Maji Salama: Implementing Ceramic Water Filtration Technology in Arusha, Tanzania

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"Water and Sanitation is one of the primary drivers of public health. I often refer to it as ‘Health 101’, which means that once we can secure access to clean water and to adequate sanitation facilities for all people, irrespective of the difference in their living conditions, a huge battle against all kinds of diseases will be won."

- Dr. Lee Jong-wook, Former Director-General, World Health Organization

Abbreviations

CDC – Centers for Disease Control and Prevention

E. coli – *Escherichia coli*

DALY – Disability Adjusted Life Years

HBM – Health Belief Model

HWTS – Household Water Treatment and Safe Storage

ICAITI – Central American Industrial Research Institute

MDG – Millennium Development Goals

NGO – Non-governmental Organization

NTU - Nephelometric Turbidity Units

PFP – Potters for Peace

POU – Point-of-Use Water Treatment

SWCEA – Safe Water Ceramics of East Africa

TTC – Thermotolerant Coliform

UNICEF – United Nations Children's Fund

WHO – World Health Organization

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I. Introduction

Background

Globally, diarrheal disease accounted for 2.16 million deaths in 2004; 1.81 million of which were in low-income countries (WHO 2008). Seventy-eight percent of the total deaths from diarrhea occur in African and Southeast Asian countries and the United Republic of Tanzania is one of the 15 countries that accounts for three-quarters of all diarrheal deaths (Boschi-Pinto 2008). According to the World Health Organization "88% of diarrheal diseases are attributed to unsafe water supply, inadequate sanitation, and hygiene" and in 2002 it was estimated that 1.1 billion people lacked access to improved water sources (WHO 2004; Clasen, Schmidt et al. 2007). Some diarrheal diseases common in the developing world linked to unsafe food and water are the bacteria, Escherichia coli (*E.coli*), Vibrio cholera, Shigellosis, and typhoid fever, or parasites such as *Cryptosporidium*, *Giardia lamblia*, or viruses such as Hepatitis A.

In 2004, diarrheal disease was one of the two leading causes of burden of disease and the most common cause of illness in the world (WHO 2008). In 2004, it was estimated that diarrheal disease caused 3.7% of all deaths around the world, making diarrheal disease the fifth leading cause of death; notably, diarrheal disease is the third leading cause of death in low-income countries (WHO 2008). For children under the age of five, diarrheal disease accounts for 17% of deaths worldwide (WHO 2008). In 2004, there were an estimated 4.6 billion cases of diarrheal diseases worldwide, specifically in Africa there were over 900 million cases of diarrheal diseases (WHO 2008).

Diarrheal disease is a problem that is acknowledged as a major public health problem in many low resource countries and politically, increasing attention is being directed towards drawing attention to and solving this widespread problem. In testimony before the foreign affairs subcommittee on Africa and global health house of representatives, Claudia McMurray, Assistant Secretary for Oceans and International Environmental and Scientific Affairs, stated that "Globally, diarrhea kills at least as many people as tuberculosis or malaria, and five times more children than HIV/AIDS" (McMurray 2007).

To quantify the economic effects of diarrheal disease on human health, DALYs (disability adjusted life years) can be calculated. DALYs are a calculation that quantifies "years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health" (WHO 2008). DALYs in Africa are at least twice as high as in any other country (WHO 2008). Around the world, diarrheal disease is responsible for the loss of 72,776,516 DALYs (WHO 2008). In Africa, diarrheal disease accounts for the loss of 32,203,037 DALYs; of those life years lost due to diarrheal disease, children in Africa under the age of 5 account for the majority of DALYs, specifically, 26,605,424, are lost (WHO 2004).

In order to prevent diarrheal diseases, water and sanitation interventions have been implemented in many developing countries in hopes that an effective method or combination of methods will achieve sustainable results leading to reductions in the rates of morbidity and mortality. Currently, there are four types of water and sanitation

interventions promoted in developing countries: water provision, household water treatment, hand-washing promotion, and sanitation. Water provision entails improvement of the supply of water, i.e. creating household connections, public standpipes, boreholes and protected dug wells, protected springs, and rainwater collection. Household water treatment coupled with the safe storage of treated water includes the use of chlorination, solar disinfection, ceramic filtration, and a flocculent or disinfectant powder and is considered effective at treating improved and unimproved water supplies (CDC 2008).

Proper hand-washing with soap is also one of the most important steps in reducing the transmission of infectious diseases that make people ill (UNICEF 2006); emphasizing when one should wash their hands – for example, before preparing or eating food, after going to the bathroom, after changing diapers or cleaning up a child who has gone to the bathroom, before and after tending to someone who is sick, after blowing your nose, coughing, or sneezing, after handling an animal or animal waste, after handling garbage, before and after treating a cut or wound, and after caring for a sick person – is important.

Improving sanitation is the fourth category of interventions that can lead to a reduction in diarrheal disease. An estimated 2.4 billion people worldwide lack access to improved sanitation which would involve establishing public sewer connections, septic system connections, pour-flush latrines, pit latrines, and ventilated pit latrines;

furthermore, eliminating open defecation and poor hygiene would help achieve improved sanitation (CDC 2008).

A review of these four interventions for water treatment was conducted and found some interventions to be more effective than others. Within the household water treatment intervention, some interventions reduced diarrheal disease in developing countries. After six trials of interventions at the water source were conducted, researchers found no difference in the number of episodes of diarrhea using rate ratios, however, trials of household chlorination, solar disinfection, and filter usage were each found to have statistically significant results in the reduction of diarrhea episodes among all age groups, including children under five years of age (Clasen, Schmidt et al. 2007). Five trials of household based flocculation-disinfection were found to have no statistically significant effects on the reduction of diarrhea episodes for children under the age of five when compared to the controls (Clasen, Schmidt et al. 2007) Despite disappointments in the effect of flocculation on diarrhea reduction, point of use or household water quality interventions were found to be more effective than previous published research had acknowledged providing about a 15% reduction in diarrheal diseases (Fewtrell, Kaufmann et al. 2005).

Amid the ongoing problem of inadequate sanitation and access to safe water which so many around the world face, support has gathered behind the Millennium Development Campaign which set eight goals to reach in 189 countries by the year 2015, and if achieved, would end poverty (MDG Monitor 2007). Goal seven of the eight

Millennium Development Goals seeks to ensure environmental sustainability. In order to reach this goal, one of the targets is to "Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation"(MDG Monitor 2007). According to UNICEF, the world as a whole is on track for meeting this goal; however, 23 countries are falling behind (WHO/UNICEF 2004; UNICEF 2006). The Joint Monitoring Program for Water Supply and Sanitation (JMP), a program of the World Health Organization and UNICEF, estimated that global coverage of safe water increased from 78% in 1990 to 83% in 2004, which resulted in 1.2 billion people gaining access to improved drinking water sources (UNICEF 2006). Notably, overall improved sanitation may not be achieved in 41 countries, making this goal unlikely to be met (UNICEF 2007). Though there have been improvements in many countries, there is still work to be done to affect a global change.

Tanzania

Sub-Saharan Africa is most notably and most disproportionately affected by the lack of access to safe water. In 27 African countries, over 30% of their populations lack access to safe water; nine of those countries have populations where over 50% of people lack access (McMurray 2007). It is also estimated that "40% of all child deaths from diarrhea are in Sub-Saharan Africa" (McMurray 2007). Most of Africa is not on track to meet the Millennium Development Goals and it is estimated that in order for Africa to meet this goal, over 23 million people will have to gain access to an improved

water source each year (McMurray 2007). “Improved water source” is a term defined by WHO referring to

> “types of technology and levels of services that are more likely to provide safe water than unimproved technologies. Improved water sources include household connections, public standpipes, boreholes, protected dug wells, protected springs, and rainwater collections. Unimproved water sources are unprotected wells, unprotected springs, vendor-provided water, bottled water (unless water for other uses is available from an improved source) and tanker truck-provided water” (WHO 2009).

Unfortunately, having an improved water source does not always result in safe water. Contamination can still occur in transport or by mishandling, therefore point-of-use treatment should also be used.

In Tanzania, “recent Ministry of Water figures suggest that 70% of the rural population, and 30% of urban dwellers have no access to safe water” and over 80% of Tanzania’s population lives in a rural area (WaterAid; Haysom 2006). Resultantly, diarrhea is said to account for at least 20% of infant deaths (WaterAid). In Tanzania’s Water Policy of 2002, it was stated that one of the specific targets of the Tanzanian 2025 Development Vision was to have universal access to safe water. Safe water, as defined by WHO, “does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages”(WHO 2004). The policy continues on to state that water, “is one of the most important agents

to enable Tanzania [to] achieve its [other] Development Vision objectives (both social and economic), such as eradicating poverty, attaining water and food security, sustaining biodiversity and sensitive ecosystems" (Tanzania National Water Policy 2002).

Safe Water Ceramics of East Africa

Safe Water Ceramics of East Africa (SWCEA) is a Tanzania based, non-governmental organization (NGO) that works with communities in Arusha, Tanzania and is partnered with Agua Pure, another NGO with headquarters in Jarabacoa, Dominican Republic. SWCEA operates a ceramic production facility in the village of Ngulelo and an education center in the village of Sing'isi. The center currently produces ceramic pottery and employs local painters to decorate this form of art. It was determined by Tracy Hawkins, the founder and program director of SWCEA, that the production facility could use their ceramicists' craftsmanship to create water filtration systems to better serve the needs of the community.

After volunteering for a pottery training program in Arusha, Tanzania in 2005 at the Sing'isi Vocational School, Tracy decided to take on the program as a personal project to help local ceramicists generate income through the sale of pottery to tourists. However, while conducting research for this project, she learned of the Potters for Peace ceramic water filter model. Faced with the opportunity to use existing pottery skills to solve the problem of unsafe water in Arusha, Tracy brought the idea of using the ceramicists' skills at the Sing'isi pottery program to create filters to the staff. The staff acknowledged the seriousness of the lack of safe water in their community and showed

full support for creating filters to help alleviate this problem. One reason the staff was so receptive is that, as noted in a February 2008 article in the Arusha Times, the city's local news source, outbreaks of cholera have appeared in nearby slums and have been a problem for years (Hashim 2008).

With the help of Manny Hernandez, Technical Advisor for Potters for Peace and Northern Illinois University professor, an implementation plan was created along with ceramic water filtration manufacturing equipment in Tanzania. Tracy then teamed with Lisa Ballentine, the founder of Agua Pure, a commercial ceramic water filter company which sought to relieve the need for clean and safe drinking water in the Dominican Republic. Through their partnership, Tracy and Lisa have established Filter Pure, an umbrella non-profit organization which merges their individual projects in Tanzania and the Dominican Republic into one organization with a common mission: to implement

> "sustainable ceramic water filtration projects world-wide, reducing poverty by providing employment opportunities, improving human survival and well-being, and educating the population on water, health, sanitation, and lifestyle issues while always maintaining respect for the culture and the individual."

By employing local ceramicists and instilling effective filtration technology, Safe Water Ceramics of East Africa supports Tanzanians in creating their own solutions to a distressing and constant problem.

Project Goals

The question this thesis aims to answer is "How can ceramic water filtration projects be effectively implemented for maximum uptake within small, rural settings in Tanzania?" In order to investigate these factors, specific goals were outlined for the project by Safe Water Ceramics of East Africa. SWCEA's goal for this project was to reduce the occurrence of diarrheal diseases through the creation and implementation of ceramic water filters. SWCEA also sought to increase awareness of the existence of ceramic filters in hopes that filters' usage would increase once people became more aware of them.

Safe Water Ceramics of East Africa's goals in this project support the requirements of Tanzania's National Water Policy, specifically their policy issues in rural water supply, which includes the following:

"Choice of technology
Goal: A mechanism enabling communities to make appropriate choices of technology.

Failure of some of the rural water supply schemes has been attributed to inappropriate technology and location of facilities, and lack of social acceptability and affordability. In order to put in place a mechanism which will allow communities to make informed choices of technology the following will be undertaken:

(i) Communities will be empowered and facilitated to make appropriate technology choices that suite [sic] them, particularly which require low investment costs and are least costly in operation and maintenance" (Tanzania National Water Policy 2002).

Through this project, SWCEA will produce a low-cost, locally made, sustainable filter that is capable of empowering a community by employing individuals who will create,

distribute, and educate others in their own community and neighboring communities about the importance of water treatment and the benefits of using a ceramic water filter.

The goals of this thesis include the following:

1) determining the effectiveness of ceramic filters in providing safe drinking water by comparing the bacterial contamination of water purified by ceramic filter versus participants' pre-study method of purification;

2) determining the extent to which ceramic filters are acceptable replacements for participants' pre-study systems of obtaining drinking water;

3) gaining insight into user perceptions of the barriers and benefits to using ceramic filters; and

4) providing assessment-based community education about the importance of water hygiene, safe water storage, and household ceramic water filters.

II. Literature Review

Household Water Treatment or Point-of-Use Technology

As described in the previous section, it has been found that point-of-use water treatment technology is among one of the most promising methods of reducing diarrhea among those who lack access to safe water (Arnold and Colford 2007; Sobsey, Stauber et al. 2008). “Point-of-use (POU) water treatment technology has emerged as an approach that empowers people and communities without access to safe water to improve water quality by treating it in the home” (Sobsey, Stauber et al. 2008). The treatment of water in the home helps to prevent recontamination during transport from the water source and enables people to take charge of the safety of their water. A meta-analysis conducted by researchers referring to point-of-use water treatment projects stated that “randomized impact evaluations of point-of-use water treatment systems observe statistically significant reductions of 20–30 percent in diarrheal incidence at the household level,” (Zwane and Kremer 2007) however, some individual studies used in the meta-analysis reported 24-29% and 44-53% reductions in diarrheal incidence (Reller, Mendoza et al. 2003; Quick, Venczel et al. 1999).

Sustaining POU treatment technology has been a challenge to achieve and very little research has been completed on the topic. Some people assume that bio-sand and ceramic water filtration systems are said to be the most promising in-house options to reducing waterborne diseases and death due to contaminated water (Sobsey, Stauber et al. 2008), while others argue that it takes more implementation factors to lead to

sustainability and that all options can be sustainable (Lantagne, Quick et al. 2006). Selection of a POU technology must involve consideration of consumers' "preference, economic considerations, cultural practices, and local water quality… [as the] needs of more than a billion people will necessitate a variety of HWTS [POU] technologies" (Lantagne 2009). Questions have been raised about whether the point-of-use technology would be permanently adopted by people despite costs of implementation in the home, change in taste of water, or slowing of the availability of water (as evident in filtration) (Zwane and Kremer 2007).

Conducting further implementation research is vital to developing and sustaining POU technology. "Many evidence-based innovations fail to produce results when transferred to communities in the global south, largely because their implementation is untested, unsuitable, or incomplete" (Madon, Hofman et al. 2007). Before transferring scientific knowledge to a community, one must rigorously investigate the extent to which the intervention can make a sustainable impact.

In order to have sustainable POU technology, many elements must come together. POU technology is not a 'one size fits all' tool to be implemented in every home that lacks access to safe water. However, there are some traits any POU technology should have if it is to be considered sustainable. A technology should provide sufficient quantities of water, be capable of producing microbiologically safe water from water ranging in levels of turbidity, organic matter, and other contaminants, require a small commitment of time from users, as well as a small amount of money,

and the technology and all its elements should be readily available and accessible for users (Sobsey, Stauber et al. 2008). Additionally, the implementation of the POU technology should be investigated to determine what criteria are needed in order for POU technology to be successfully implemented and sustained (Madon, Hofman et al. 2007). Also, the POU technology must continuously be investigated to determine the conditions needed for "long-term, sustained, and consistent" use (Lantagne 2009).

Point-of-Use Water Treatment Methods

As mentioned, various types of point-of-use (POU) water treatment methods exist and are already being implemented globally. These methods include chlorination, flocculent-disinfection, boiling, solar disinfection, and biosand filters.

Chlorination paired with safe storage, like that of the Safe Water System (SWS) promoted by the CDC, is effective at reducing bacteria and viruses in water, but not as effective with parasites. Chlorination also has the benefit of being low cost, easy to use, well accepted, and protects against residual contamination, but in more turbid waters chlorination is less effective. Concern over the taste and odor of chlorinated water also remains an issue, in addition to concern over potentially carcinogenic effects of chlorine by-products (POUZN 2006; CDC 2008).

Flocculent-disinfection involves adding a powder disinfectant made of calcium hypochlorite to water to remove bacteria, viruses, parasites, suspended organic matter, and heavy metals. After flocculent is mixed into turbid water, the matter settles causing the water's appearance to improve. In addition to leaving water cleaner, flocculent also

leaves a residual effect (Crump, Otieno et al. 2005; Chiller, Mendoza et al. 2006). Flocculation yields a reduction in viruses, protozoa, and bacteria in water, reduces heavy metals and pesticides, has residual protection against contamination, visually improves the water which leads to user satisfaction, and the sachets that the flocculent powder are packaged in are easily transportable due to their small size, long shelf life, and are non-hazardous when considered for air shipment (CDC 2008). However, flocculation involves multiple step, which are best taught through demonstration. Users also need to have access to at least two buckets, a cloth, and stirring device, which may be inaccessible for most users, and compared to other methods of water treatment, water treated through flocculation is considered more expensive per liter of water (CDC 2008).

Boiling water is the most common and oldest method of household water treatment. Boiling is one of the most effective ways to kill or deactivate waterborne pathogens. Unfortunately, boiling water is costly when compared to some other methods of water treatment. Burning requires fuel, a kettle and/or stove and other equipment for boiling water. The majority of the world's population relies on wood, charcoal, or biomass as a fuel source and these resources generally take time and energy to collect, if they are not purchased. The acquisition of these resources is usually the responsibility of women and young girls, and therefore requires more time away from other responsibilities or activities (Clasen, Thao do et al. 2008). The burning of these fuels for boiling water has also been linked to health hazards like respiratory infections from poor indoor air quality and burns. The burning of these fuels is also thought to be environmentally unsustainable and a contribution to greenhouse gases.

Additionally, boiled water is not protected against residual contamination (Clasen, Thao do et al. 2008).

Solar disinfection (SODIS) was developed in the 1980s originally for the disinfection of water used for oral rehydration solutions, which are used to treat diarrhea. With solar disinfection, users fill 0.3-2.0 liter bottles with water that is low in turbidity. Bottles are then shaken so they become oxygenated and placed in sunlight, preferably on the roof or a rack for six hours if sunny and two days is cloudy. "The combined effects of UV-induced DNA alteration, thermal inactivation, and photo-oxidative destruction inactivate disease causing organisms" (CDC 2008). SODIS has been shown to be effective at reducing viruses, bacteria, and protozoa and their resulting diarrheal diseases, is easily to use and therefore well accepted, is low cost if users are already in possession of bottles, has no change in taste like that of chlorination, and is unlikely to be re-contaminated due to the shape of the mouth of the bottles. Unfortunately, SODIS requires the use of the appropriate, clean plastic bottles which may not be readily available. Extremely turbid water requires flocculation or filtration to reduce organic matter that may make solar disinfection more difficult. Also, the time needed for disinfection (six hours for sunny days and two days for cloudy days) and limited amount of water may also affect users' acceptance of SODIS (CDC 2008).

Biosand filters are composed of a receptacle often containing layers of sand, gravel, and concrete. A layer of water rests on top of the sand creating a biofilm, which aids in the removal of harmful bacteria. Initial tests found that biosand filters reduce

diarrheal disease by about 30-40% (Sobsey 2007). Sumaritan's Purse projects found that biosand filters reduced fecal coliform counts by 93% on average; however, removal rates of fecal coliform ranged from 81-100% in multiple countries (Kaiser, Liang et al. 2002). Biosand filters were found to reduce *E. coli* 93% on average in the Dominican Republic, however, reductions reached as high as 99% (Stauber, Elliott et al. 2006). Flowrates for biosand filters are relatively fast, but water with high turbidity tends to clog the filter and reduce pore size, thereby reducing the flowrate. Biosand filters are also prohibitively expensive due to the unavailability of materials and heavy (Yung 2003; Lantagne 2009).

Ceramic Water Filtration

Ceramic water filtration is another POU method of water treatment. Filters are made of clay mixed with water and a combustible material, like sawdust, and then fired. When filters are fired, sawdust burns out leaving tiny pores that provide the first line of defense in water treatment; if pores are larger, water flows faster, while smaller pores lead to slower flow rates of water. The pore and flow rate of the filters varies depending on the size of the combustible particles used in the mixture, however a screen is used to select sawdust or other combustible material that measures out to 1.3 microns, as the pores resulting from combustible particles of 1.3 microns was found to be best suited for removing bacteria and protozoa while filtering a sufficient quantity of water (FilterPure). The possibility of removing all bacteria or protozoa from water exists

with the smallest of pore sizes, however, the rate at which water flows will also decrease (Brown, Sobsey et al. 2007).

Colloidal silver, which is either used to coat after firing or impregnate the filter while being mixed, is believed to act as a disinfectant by preventing bacteria and protozoa from surviving in the filter and provide the second line of defense in water treatment as water flows through the filter, however, the effectiveness of colloidal silver in the disinfection process is currently being questioned. Ultimately, filters are effective in reducing or eliminating bacteria like *E. coli*, protozoa like *Giardia lamblia* and *Cryptosporidium parvum*, and turbidity (Lantagne 2001). According to Water and Sanitation Field Notes from UNICEF,

> "Locally produced ceramic pot-style filters have the advantages of being lightweight, portable, relatively inexpensive, chemical free, low-maintenance, effective, and easy to use. The filters provide for removal of microorganisms from water by gravity filtration through porous ceramics, with typical flow rates of 1-3 liters per hour. They cool the treated water through evapo-transpiration and, used with a proper storage receptacle, safely store water for use" (Brown, Sobsey et al. 2007).

As ceramic filters can be crafted on presses by local ceramicists and many of the materials required for filters are found in most environments, ceramic water filtration also provides local economic opportunities.

The first ceramic water filters were created in 1981 in Guatemala by Dr. Fernando Mazariegos of the Central American Industrial Research Institute (ICAITI) and were adopted by Potters for Peace (PFP), a US-based NGO founded in Nicaragua in 1986 which is devoted to socially responsible development and grass roots accompaniment among potters (PottersForPeace 2006). Ron Rivera, a sociologist and potter, heard of these filters and had been marketing the PFP filters in Ecuador. Rivera subsequently began working with Potters for Peace, helping to create a ceramic water filter production workshop, which was needed in order to supply filters to areas of Nicaragua devastated by Hurricane Mitch in 1998 (PottersForPeace 2006). Since the creation of this workshop, which is a worker-owned cooperative, Potters for Peace has provided consultation and/or training in the creation of 30 production facilities (PottersForPeace 2006). Fully equipped factories with presses that produce filters full time exist in Nicaragua, El Salvador, Guatemala, Ghana, and Cambodia (Lantagne 2006). In Honduras, Myanmar (Burma), and Chihuahua (Mexico), filters are only produced on order. In Cuba, Bali, Sri Lanka, Ecuador, and Thailand, factories are equipped at some level, but Potters for Peace is unsure of whether these factories are currently producing filters. Filter projects in Iraq, Haiti, Sudan, and Bangladesh have been discontinued. Most recently, projects in Benin, Kenya, Tanzania, Colombia, the Dominican Republic, Peru, and Senegal have been completed. Projects in Ivory Coast, Bolivia, and Somaliland are planned for 2009 (PottersForPeace 2006).

A study conducted over a six month time period in rural Bolivia found that ceramic water filters based on the PFP model eliminated all thermotolerant coliform

(TTC), which is an indicator of contaminated water supplies (Clasen, Brown et al. 2004). The elimination of TTC was linked to a significant decline in diarrhea. What researchers found to be most notable about the filters, was that they were inexpensive to produce, easy to use, and did not require much advertisement or publicity to engage people in their use in one program (Clasen, Brown et al. 2004).

Despite positive results from some research studies, further research into ceramic water filters is being conducted to improve on the existing technology due to variation in filter manufacturing practices. Potters for Peace (PFP) recommends that filters have flow rates between 1-3 liters of water per hour and be coated on the inside and outside with colloidal silver to provide 100% removal of all coliform from water, however, PFP found that removal of bacteria was still variable during experimental stages of their research and there are still vital questions left. The filter made by Potters for Peace was then transferred to Honduras and Bolivia to determine whether filters were feasible for a different population. Though the filters removed up to 100% of bacteria from tainted water, the filters ultimately failed in Bolivia due to lack of marketing (Lantagne 2001).

In Cambodia, researchers gave out 2,000 PFP filters and had 506 households participate in a study to determine whether filters were being successfully adopted. At the time of follow-up, researchers found that only about 31% of participants were still using the filters regularly. Of those who were not using their filters still, 65% of those participants reported having broken their filters, thus being unable to use them.

However, microbiological testing revealed that filters significantly reduced bacteria, like *E. coli*, up to 99.99% (Brown, Sobsey et al. 2007). The mean reduction in *E. coli* was 98%, possibly due to improper cleaning of filters, noted by researchers. It was reported that 29% of participants cleaned their filters with raw water only; this can cause filters to become contaminated thereby reducing filters' effectiveness (Brown, Sobsey et al. 2007).

III. Methodology

Behavioral Change/Theories

For this study, behavior change communication was needed to encourage potential users in Arusha to use their ceramic water filters to treat their water. In order to change behavior, an implementing organization must first understand the behaviors behind existing actions. One model that helps to explain existing behavior and how to modify that behavior regarding water treatment is the Health Belief Model. The Health Belief Model (HBM) is based on the tenant that people will take appropriate actions to modify their health, granted they see that negative effects could result from failure to change (Glanz 2002).

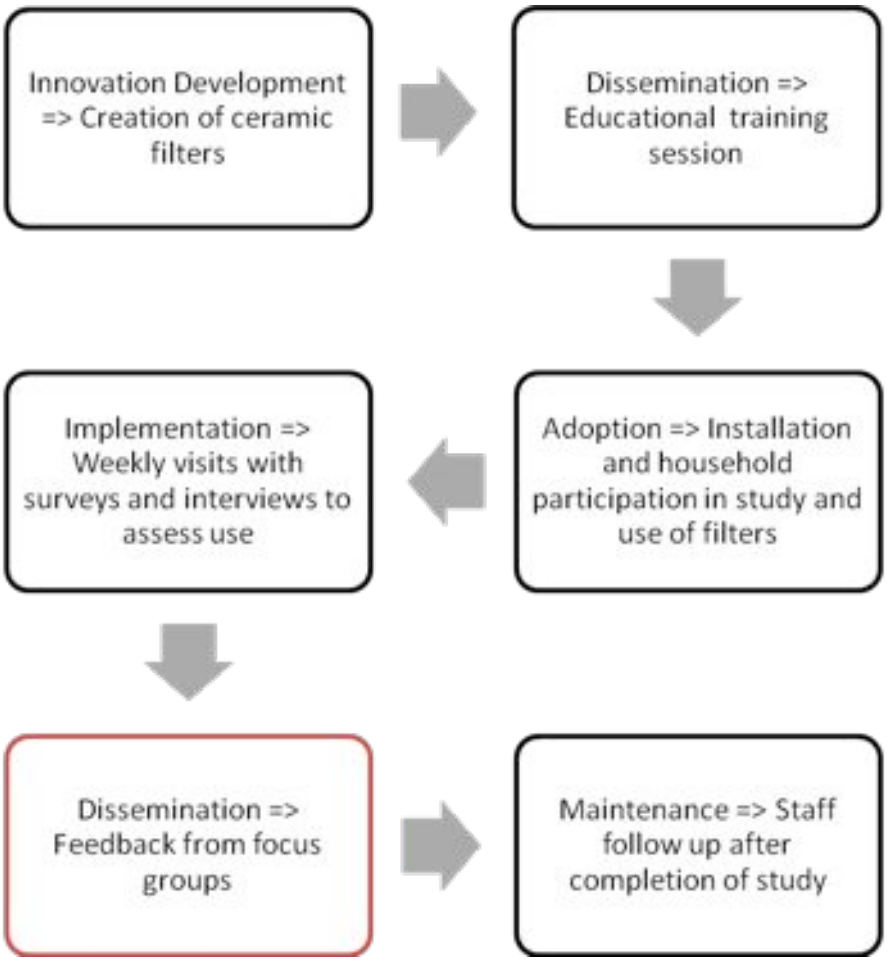
The Health Belief Model is composed of six concepts – perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. Each concept explains possible behavior change; for example, perceived benefits refers to benefits people may think they will see resulting from the use of ceramic water filters. If people think the filters will make the water look cleaner, this is a perceived benefit of the use of the filter and could result in a participant implementing the use of filters in their household. Perceived susceptibility and perceived severity refer to whether people feel that they are likely to be affected by the consequences (i.e. diarrheal disease) of not taking action by using ceramic filters, and if they are affected by it, how severe the results would be if they chose not to take action. Perceived barriers refers to potential obstacles, whether physical, mental, or emotional, that may

prevent a person from taking part in an intervention or choosing to modify their own behavior. Cues to action are prompts, whether tangible or intangible, that cause a person to act on behavior change. Self-efficacy, which is a concept used in many behavioral theories and models, refers to one's perceived ability to make necessary behavior change (Glanz 2002). Self efficacy in this study could refer to people's ability to prevent diarrhea disease, as well as, their ability to treat their water with ceramic filters.

The concepts of the Health Belief Model can be used to help determine factors related to the implementation of ceramic water filters as a water treatment technology. While implementing ceramic water filters in Arusha, barriers to the use of ceramic filters were investigated in order to accurately target educational messages to encourage behavior change. Benefits to filter use were explained to participants to encourage them to use the filters on a regular basis. Susceptibility and severity of diarrheal diseases were discussed with participants to help them understand the importance of water treatment, specifically through the use of ceramic filters. Cues to action were thought of and in most cases were coupled with susceptibility and severity to encourage people to modify their behaviors. Self-efficacy, which is one of the most important concepts, was a large focus in that in order to effectively implement the use of filters, people using them must feel comfortable and confident with this new technology. In order to address this, people were taught how to use the filters and were educated about the importance of the filters.

Another behavioral theory, Diffusion of Innovations, was also used to guide the research study in Tanzania. Diffusion of innovations involves five stages of changing behavior: innovation development, dissemination, adoption, implementation, and maintenance. Innovation development consists of the creation stages of an innovation, which could be an idea or product. Dissemination is the transfer of knowledge about the product to the users. Adoption is the "uptake" of the product by the "target audience"(Glanz 2002). Implementation refers to the use of the product in practice, or for the role in which it was created. Maintenance refers to the continued implementation of the product (Glanz 2002). The way in which Diffusion of Innovations was adapted and applied towards the implementation of the ceramic water filters within the study communities is shown in Figure1. Dissemination was modified to include a second step, where focus groups disseminated information to the investigator. Maintenance involving staff follow up with participants would have been ideal to determine the long term effectiveness of filters, but unfortunately could not be done due to limited resources, staff members, and time.

Figure 1. Application of Diffusion of Innovations



Diffusion of Innovations also involves certain attributes that help determine how easily and to what extent an innovation can be implemented. When distributing ceramic water filters, many of the following attributes were taken into consideration: “relative advantage, compatibility, complexibility, trialability, observability, impact on social relations, reversibility, communicability, time, risk and uncertainty level, commitment, and modifiability” (Glanz 2002). When considering filters’ capacity for being

implemented effectively, it should be noted that attributes of the filters align themselves with key determinants of the Diffusion of Innovations. For example, filters in many cases are a better substitute for people's current method of water treatment; notably, many participants in the study were not treating their water in any way. Filters were easy to use, had no negative effects on the "social environment" of the community, were able to be adopted easily with minimal risks, investments, or time.

Research Design

Before the onset of this study, 50 filters were made by SWCEA for use among study participants. SWCEA creates filters similar to those of the PFP model with slight modifications. SWCEA's filter mixture is composed of clay soil, sawdust, water, and colloidal silver. The mixture is pressed, yielding a round bottomed filter, which differs from the PFP flat-bottomed filter. Filters are then left to air dry; the time it takes filters to dry ranges from a few days to approximately 3 weeks depending on the level of moisture in the air. After filters air dry, they are then fired in a kiln at a gradually increasing temperature that eventually reaches 900-950 degrees Celsius. After filters are fired, they are then ready for use.

Currently, there is little data about the acceptance of ceramic water filters by users, so this study sought to gather feedback from participants that could help inform researchers about users' usage of and opinions of the filters. A mixed method study (including both household surveys and water quality testing) was chosen because it gathered both quantifiable information that could be generalized to other populations

and then built on the quantifiable data to gather more in depth information about usage and water treatment practices before the use of the filters.

Once 50 filter units were assembled, they were driven to the two communities in which the study was conducted and distributed to participants at the mandatory educational sessions that took place before the study began. Families then chose their filters and took them home where they were instructed to clean filters with boiling water before using them.

Over an eight-week period from June to July of 2008, household visits were conducted where surveys were used to collect demographic data, information on water treatment methods, and filter usage which contained both quantifiable data, as well as open ended qualitative questions. Participants were also encouraged to give any additional information that they felt was necessary in order to improve the production of the filters. Additionally, samples of water were collected from each village to be tested for total coliform and *E. coli*; samples were composed of source water (i.e. rivers, streams, etc.) and piped or local sources, as well as filtered water from the ceramic filters.

Target Population and Sample

The target population for this study consisted of all people living in Arusha, Tanzania. The sample consisted of 50 participating households from two communities within the city of Arusha - Sokoni and Nambala; there were 25 participating households from each community. Communities were selected based on their representativeness of

the Arusha population. In order to participate, subjects were required to live in one of the two communities, have at least one child under the age of five, and attend the educational session held at the beginning of the study to learn about proper use and maintenance of the filter. Community leaders from Sokoni and Nambala were asked by a Safe Water Ceramics of East Africa staff member to compile a list of households that met the inclusion criteria and invite them to the educational session where they would be informed about the study and decide whether they would participate. Convenience sampling was used in recruitment and all participants were informed through word of mouth, as this was most appropriate for a community-oriented, low resource setting.

The sample size was determined by considering what was feasible for the study. Household visits were conducted in Sokoni and Nambala on alternating weeks, so a given community's participants would be visited bi-weekly. Both communities are rural, most homes were distances apart, and the people of Arusha are mostly agricultural, so there were many occurrences where the participant was unavailable due to work, so the research team was required to make multiple visits to a household to collect data.

Flow Rates

Before being distributed, filters were tested to determine their flow rates. The recommended range of flow rates is 1-3 liters per hour. Testing was required in order to determine whether filters produced by Safe Water Ceramics of East Africa met the recommended flow rate. Each filter was measured and flow rates were recorded by the

investigator to compare with *E. coli* levels to determine if there was a relationship between the flow rate and amount of *E. coli* found in the filtered water.

To conduct flow rate testing, water was poured into filters which sat over an empty receptacle bucket. After 30 minutes, the amount of water that flowed through the filter into the bucket was measured and recorded, yielding the flow rate per half hour, which was then doubled to yield a rate of liters per hour. Flow rate testing was conducted for each filter. Once filters were tested for flow rates, they were placed in receptacle buckets with handles and a plastic spigot or tap; all buckets came with a top that fit over the filters and sides of the bucket to prevent any contamination. Filters were then ready for distribution.

Water Quality Testing

To determine the effectiveness of ceramic water filters microbiological tests and turbidity tests were conducted on filtered water. All water samples were collected in sterile WhirlPak bags containing a chlorine deactivating agent. All bags were stored in a small cooler with ice packs immediately after collection and were tested within eight hours of collection.

Membrane filtration was conducted in order to test water samples collected from each household for the microbiological indicators, *E. coli* and total coliform. In order to perform membrane filtration, 100 milliliters of sample water collected from each household was run through a 0.45 micron filter on a metal filtration apparatus; any particles that were in the water were strained through the apparatus and left on filters,

which were placed into a petri dish coated in mColiBlue 24 medium. A positive and negative control consisting of purified water and contaminated water was run before each set of samples to ensure the equipment and filtration process was operating correctly.

Petri dishes were incubated over a 24-48 hour period, depending on the availability of electricity. Once colonies formed they were visible to the eye; the presence of blue colonies represented *E. coli*, while the presence of red colonies represented total coliform. Colonies grown in each petri dish were counted manually. Coliform is found in the intestinal tracts of human beings, as well as in the environment, therefore it is a commonly used indicator for the presence of human feces in water. *E. coli* is a bacteria which causes gastroenteritis in humans, is present in both animal and human feces, and "always indicates potentially dangerous contamination requiring immediate attention" (WHO 1996). By identifying the types of bacteria and their frequency within samples, one can estimate the level of contamination at the source. Microbiological test results were analyzed using Excel.

In order to determine the turbidity of the sample water, water was tested in the LaMotte 2020 turbidity monitor. Sample water was poured into clear vials then light from the monitor shone through the vials determined how turbid water was. Control vials of 1, 10, 100, NTU were tested so that sample readings were accurate upon testing.

Survey Methodology

This study was approved by the Emory University Institutional Review Board. In order to obtain informed consent, each participant was visited in their home. With the assistance of a translator, each participant was read aloud the informed consent and either gave their consent orally or signed their name on the form. Participants were given a copy of the informed consent to keep for themselves. After each participant gave their consent, the first survey was administered. The first survey administered to each household collected demographic data and data on water use and treatment prior to using the ceramic filter; each subsequent survey consisted of questions about the filters' usage during the course of the 8 week study. The final survey gathered more information about the filters' usage and information on participants' overall satisfaction with the filters.

Participants received no compensation for their participation in the study, however, they received free ceramic water filters, thus this was considered a benefit of participation. Participants were visited at their homes by the Principal Investigator and translator on a bi-weekly basis over an 8 week period. The Principal Investigator completed surveys with participants and stored them safely in a locked cabinet, which was in the Principal Investigator's room, which remained locked while the Principal Investigator was away. Additionally, all surveys were de-identified, meaning personal identifiers were removed. Data entered from these surveys onto the Principal Investigator's computer was stored safely and was password protected. This computer was also stored in a locked cabinet, in a locked room.

Survey Development

Data collection instruments were created by the Principal Investigator; they were composed of open-ended and scaled questions. Three surveys were created to capture information from participating households. The first survey was administered on the first visit and collected information on family demographics, household problems, knowledge about diarrhea, water use practices, and household hygiene and sanitation. The initial survey was composed of 58 questions read aloud to participants; 6 questions were present on the survey but were not read to participants, instead they were used for observations by the Principal Investigator. Initial surveys consisted of 41 multiple choice questions and 17 open, short answer questions, mostly used to expand on the answers to the multiple choice questions.

The second survey was used weekly to gather information about filter usage, maintenance, and satisfaction. This survey consisted of 26 questions total, 13 of which were multiple choice, and 5 which were likert-scale questions. One likert-scale question used a scale of 1 to 4, 1 representing very satisfied, 4 representing not at all satisfied. Four of the likert-scale questions that sought to gain information about filter quality ranged from 1 to 5, 1 representing excellent, 5 representing terrible. The remaining questions were open-ended, short-answer questions. The final survey was used on the last visit to each household to gather data on filter usage, maintenance, overall satisfaction, and ideas for improvement of the filters. There were 17 multiple choice questions, 6 varying likert scale questions, and the remaining questions were open ended, short answer questions.

All survey data was analyzed using SPSS 16.0. Surveys were written in English so that the Principal Investigator could read questions aloud to participants; however, a translator was present to translate all questions for the Principal Investigator and help with clarification for the participants. Surveys were created based on pre-existing surveys used in studies in Haiti and Niger, but were adapted to be more applicable to Tanzania's population and more relevant for addressing the research question.

Focus Groups

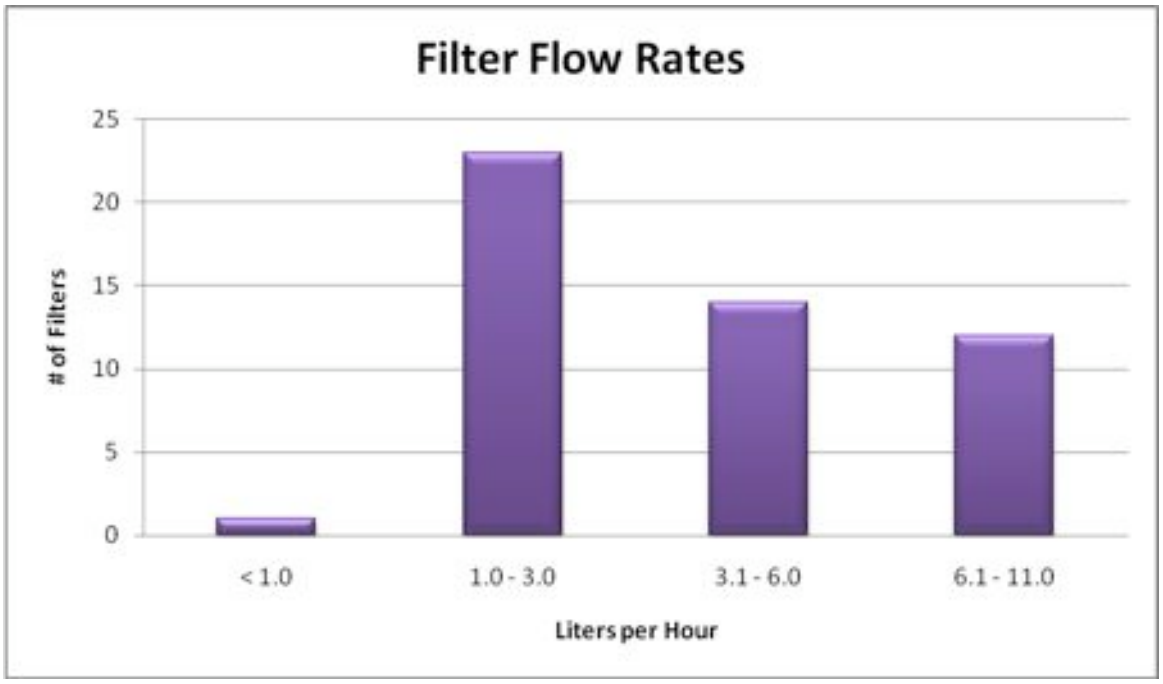
At the completion of the study, focus groups were held to gain more detailed information from users about the usage and maintenance of filters. Focus groups were semi-structured, in that the investigator created a guide of questions to ask participants, but left the group discussion open for participants to discuss whatever they felt was pertinent regarding the filters. The investigator mediated the group when necessary and had a translator present to provide clarification to either participants or the investigator.

IV. Results

Flow Rate Testing

The range of flow rates that Potters for Peace recommends is between 1-3 liters per hour. For filters produced by SWCEA, flow rates ranged from 0.3 liters per hour to 10.8 liters per hour. Results are shown in Figure 2 below.

Figure 2. Frequencies of Flow Rates



Flow rates were substantially higher than the recommended rates from Potters for Peace. This could be due to errors in the mixing process causing filters to have larger pore sizes or cracks and crevices that allow more water to flow through the filter. Notably, the flow rates seem to have no considerable effect on the amount of *E. coli* that is found in the filtered water. A linear regression was run on the flow rates and

actual *E. coli* values and yielded an R^2= 0.0488, signifying that about 5% of the variance in the amount of *E. coli* present in filtered water can be explained by flow rates. However, because this was not the focus of this study, further research should be conducted investigating the association between flow rates and *E. coli* levels.

Water Quality Testing Results

At the time of the study in Arusha, seasonal rainfall was still constant leading to a cleansing of all water sources. Because of this, the clarity of most source water was relatively good. The appearance of water however, is not related to its microbiological safety. Average turbidity at baseline using pre-filtered drinking water for all households was about 1.54 NTU. The second time water was collected and tested from all households, filtered water was what was used and yielded an average turbidity of 0.53 NTU. The final collection of water from household's filters had an average turbidity of 0.28 NTU. Paired t-tests were used to compare the turbidity for each visit among all households. When comparing two tailed p values, none of the results showing a decrease in turbidity over time were statistically significant.

Despite the clarity of the households' drinking water in Sokoni and Nambala, their bacteria levels were still unsafe for drinking. Over the eight week study, *E. coli* and total coliform levels were measured in participants' drinking water. The amount of total coliform was so abundant in the water supply that many samples were too numerous to count before and after filtering. Though reductions in total coliform may have resulted from the use of ceramic water filters, using only *E. coli* for the bacterial indicator was

the most efficient. In many cases, *E. coli* is present in lower numbers and therefore, is easier see differences in its presence in water.

In the two graphs below, the reduction in *E. coli* among communities over the life of the study is presented. Though some *E. coli* was still present in participants' drinking water even after filtering, it is important to note the reduction in overall *E. coli* levels over time – as many families moved from a higher risk group to a lower risk group. Bacteria could be present in the filtered water for many reasons. Due to the lack of quality control at the factory, the quality of filters could be poor, leading to contaminated water escaping through crevices and cracks in the filter, rather than colloidal silver treated pores. Also, confusion about how to properly wash filters could have led to participants cross-contaminating their filters, thus preventing filters from working as efficiently as they could.

Figure 3. *E. coli* Presence in Sokoni Water

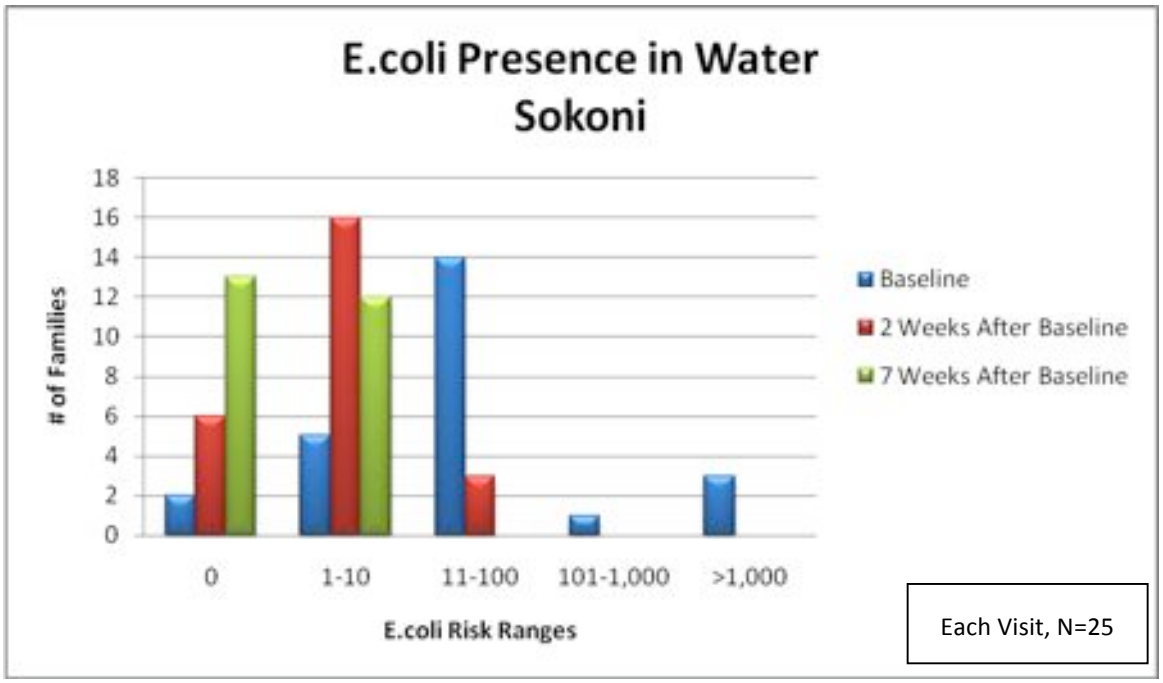
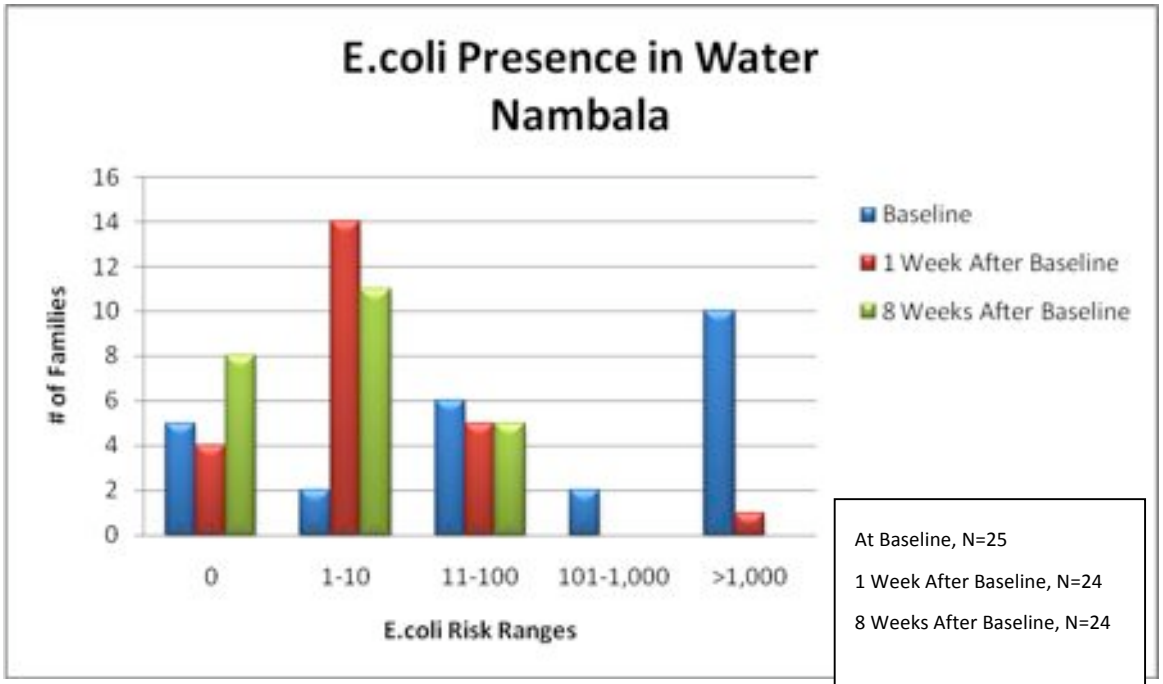


Figure 4. *E. coli* Presence in Nambala Water



Surveys

Initial Visits

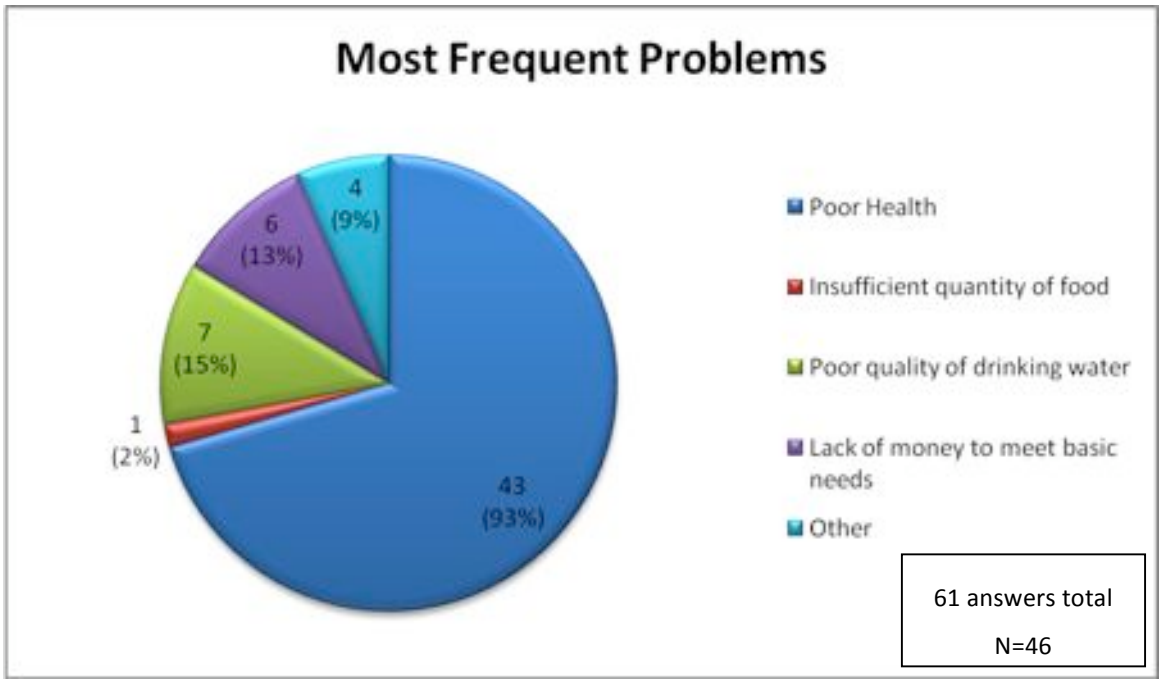
Initial visits to households were used to collect demographic data about participants and background information regarding participants' water use, water treatment routines, incidence of disease, priorities, and general information about participants' health, and knowledge of health related topics. Participants were willing to answer all questions, so the response rate was 100% except for a few participants who were unavailable during the week of household visits to their communities.

Most respondents were mothers (82%); this is appropriate since women are usually the ones to collect and treat water for the household. Ages of respondents ranged from 20-70; some grandmothers were in care of their grandchildren, making them eligible for participation in the study. The majority of respondents were literate (92%) and had attended school for seven years (76%). The average household consisted of six people; all households had a child that was five or less, as this was inclusion criteria for being a participant in the study. The median monthly income for all participating households was 60,000 Tanzanian Shillings (Tsh), which is equivalent to approximately 47 USD.

When asked about the incidence of diarrhea in the last week for all members of the household, 10% of participating households had a family member who suffered from diarrhea; 60% of family members with diarrhea were five years old or less.

Respondents were asked to name the three biggest problems that their family faced. The results are presented in Figure 5 below:

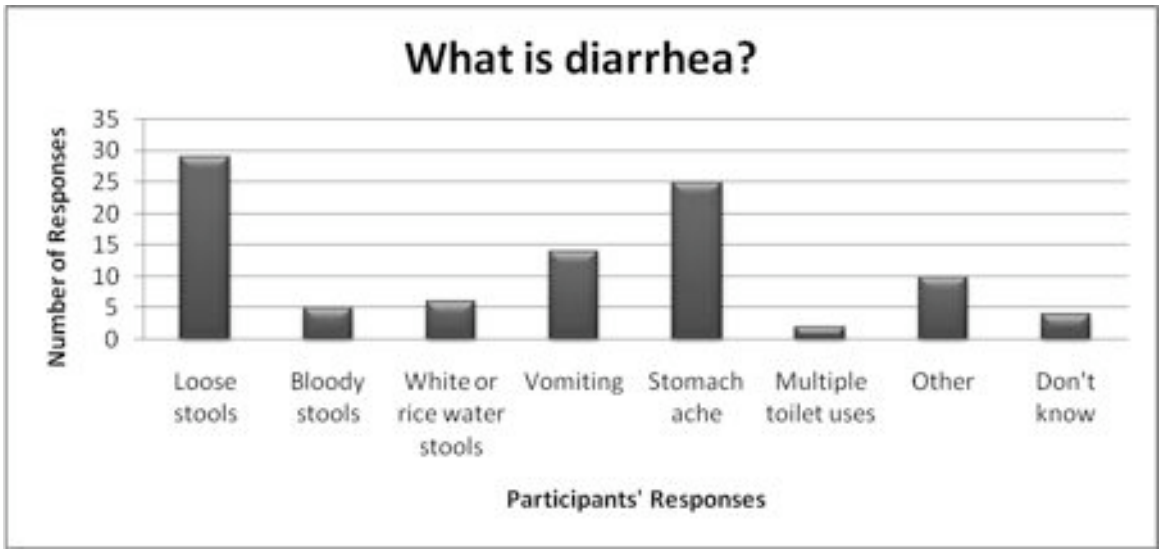
Figure 5. Most Frequent Problems Faced by Households



As evident in the chart above, some respondents gave more than one answer when asked about problems they faced. Poor health and poor drinking water quality were mentioned by the majority of respondents as major problems. When asked to name the most frequent diseases faced by people in the community, overall the majority (41%) of respondents said malaria, 12% did not know what the most frequent diseases were in their community, 15% named typhoid fever, 8% named respiratory diseases and stomach ache/disease, and only 3% named diarrhea as a frequent problem. A small proportion of respondents named skin diseases, diabetes, issues with blood pressure, ulcers, fever, and flu (influenza) as frequent problems.

Respondents were asked if they knew what diarrhea was. Most participants were able to name at least one symptom of diarrhea as shown in Figure 6 below. Most respondents associated diarrhea with loose stools (53%) and stomach ache (42%).

Figure 6. Description of Diarrhea



The majority of participants said that diarrhea was caused by drinking dirty water and eating contaminated food. Many participants also commented on the cleanliness of the environment being linked to the occurrence of diarrhea. Most participants said they would treat diarrhea by going to the hospital (46%) at the first sign of symptoms (66%). Interestingly, 20% of respondents did not think it was possible for them to prevent diarrhea from occurring; this is important to know when thinking about self-efficacy in the Health Belief Model. Of those respondents who thought diarrhea was preventable, they claimed the following methods to be most effective: cooking thoroughly (30.8%), boiling or treating water (28.2%), and washing hands more frequently (15.4%).

Most respondents collected their water from outdoor taps. Taps were usually in the yard of the respondent or at a location nearby the respondents' home. Four respondents (8%) collected water from rivers or creeks, while only one respondent had running water inside their home which came from a rain collection tank outside. Of respondents who did not have running water in their house, 24% collected water 10 times per day; one respondent claimed to collect water approximately 20 times per day. The amount of time participants spent collecting water ranged from five minutes to about 360 minutes; thirty-six percent of participants spent more than one hour per day collecting water. Generally, women are responsible for collecting water in this population, though children – especially young girls – were responsible for helping their mothers collect water. Water is collected in either ten or twenty liter plastic buckets and stored in the same buckets, most of which have plastic covers. Stored water lasted between one to three days and was used for cooking, cleaning and washing household dishes and utensils, washing fruits and vegetables, washing clothes, and bathing. Because stored water was susceptible to contamination, respondents were asked how they took water from their storage containers; of those who stored water, 77.8% drew water from their storage containers with a cup. When asked whether anyone ever touched water in their storage containers with their hands when they drew water, 71.1% said no, 24.4% said yes, and 4.4% said they did not know for sure, mainly because it was possible for the children to do so without parents being aware.

The next questions on the initial survey sought to investigate respondents' water treatment behaviors. It was first necessary to assess respondents' beliefs surrounding

the safety of their water. When asked about water safety, 66% of respondents said that they thought their water was unsafe, 26% thought the water was safe, and 8% were unsure about the safety of their water. Most of the respondents who thought their water was unsafe thought so either because the water is dirty (turbid) (36.1%) or because it contained microbes. Two respondents claimed water was unsafe because it contained larva or worms. Village leaders thought water to be unsafe because the sources were not protected. When respondents were asked whether they treated their water, 36% of respondents said they always treated their water, while 62% said they never treated their water before drinking it. Of those who treated their water before drinking, 83% said they always boiled water, one participant filtered water through cloth, one participant used WaterGuard chlorine solution, and one *sometimes* used WaterGuard tablets. Generally, whenever water was treated, all members of the household - mother, father, children, elders, and guests were given the water to drink.

Participants who treated their water (n=18) were asked whether they liked the taste and smell of the water; 77.8% said they did like the taste and smell. Of those respondents, 50% (n=7) stated that they liked it because it was the water they were accustomed to while the other 50% (n=7) said the taste and smell of treated water is an indicator of the water being safe, therefore they like it. Of those who disliked the taste and smell of treated water (22.2%), 75% (n=3) said the water tasted bad, while 25% (n=1) said the smell and taste was not what they were accustomed to drinking.

Participants were asked about their practices when regarding hygiene, as poor hygiene is also thought to contribute to diarrheal disease. When asked about hand washing, participants were able to give multiple answers to explain all the occasions in which they washed their hands without prompt from the Principal Investigator or translator. Results showed that 60% of respondents washed their hands after using the toilet, 50% washed their hands before meals, 32% washed their hands before preparing and cooking food, 10% washed their hands after feeding and working with their animals, 16% washed their hands after working, 8% washed their hands after fetching water, and 16% washed their hands after cleaning the house. Data from Figure 7 below indicates the distribution of occurrences when respondents claimed to wash their hands.

Figure 7: Occasions in Which Participants Wash Their Hands

Respondents were then asked about their usage of soap. Most respondents claimed to use soap regularly (94%), though 6% of respondents admitted to generally not using soap. Of those who used soap regularly, 57.4% claimed to use soap for washing their hands, 96.9% used soap to wash clothes, 94% used soap for washing dishes/utensils, and 64% used soap for bathing. When asked where respondents' families bathe, 92% of participants bathed outdoors either in the open or in a washhouse. When asked if they ever bought water for drinking, 60% of respondents said no, 40% said yes.

The final portion of the initial survey involved observation of the participants home. For example, 94% of respondents claimed that they used soap, yet when the investigator observed the outdoor latrines of which were mostly made up of private

squat latrines (88%), it was noted that 77% did not have a place for washing their hands and 96% did not have soap near the latrine to wash their hands with after toilet use (N=48). Additionally, 67% of households did not have electricity and 98% did not have gas (N=49).

Second Visits

Upon the second visit to participants' homes, a second survey was read orally to participants and translated for the investigator. This survey focused the usage of the ceramic water filter by participants and their families. The following are the results were reported by participants and are the outcome of the second visits to both Sokoni and Nambala. Of the 46 participants who reported back on their use, 100% of them claimed to have used the filters during the past week. Ninety-six percent of participants used the filter the day before (N=47); one of two participants did not use the filter because it was leaking. On the day of home visits, 74% had already used their filter that day; the other 26% had not used the filter yet citing the following reasons: one participant had a problem with their filter, seven participants said the temperature outside was too cold to drink water, and two said it was too early in the day to drink water.

Before using the filters, participants were instructed to wash the filters with boiling water to remove any contaminants that may have settled onto the filters while in transport or when they were being stored at the factory. The buckets that the filters sat in were also supposed to be washed with soap and boiling water to ensure that the water flowing through the filters did not become contaminated once making contact

with the buckets. After washing the filter when they first received it, participants were told that the filters only needed to be washed once everything three months. If the flow rate slowed significantly, filters could be washed sooner than three months, but participants were asked not to wash the filters too often, as the ceramic material was likely to wear faster after being scrubbed so often. Upon the second visits to households, the investigator found that 41% of households washed filters after receving them, while 59% did not. When asked how filters were washed, 42.1% used a brush, 26.3% used tap water, 5.3% used boiling water, 10.5% used soap on the buckets only, and 15.8% used filtered water to clean both filter and receptacle buckets (N=46).

Regarding the usage of filters, 91.5% of participants filtered water once per day; 8.5% filtered twice a day. All participants felt satisfied with the filters and stated that the filters produced enough water for the family members and were easy to use (N=47). All participants were satisfied with the time it took water to flow through their filters and only 6% of participants had problems with their filters (N=47). When asked about the water produced from the filters, 91.3% of participants said the taste of filtered water was excellent compared to water from their previous treatment method; 8.7% tasted no difference in the filtered water compared to the water they were drinking before (N=46). Of respondents, 91.1% said the appearance of the filtered water was better (excellent) than their previous drinking water, while 8.9% did not notice a difference (N=45). Eighty-three percent rated the smell of the filtered water as excellent when compared to their previous drinking water, while 17.4% participants did not sense a

difference (N=46). All respondents claimed that all members of the household were still drinking the filtered water only (N=47).

Third Visits

Upon the third visit to households, the same survey used during the second visits was read aloud to participants to continue to collect information about participants' filter usage. According to participants' responses, all participants used the filters during the previous week, only one respondent did not use the filter the day before their home visit, and only 53% of respondents had used filters on the day of the home visit (N=49). Of the 47% who had not yet used filters, the following are some reasons given by respondents as to why filters had not yet been used: 4.3% had a problem with their filter, 56.6% felt that the weather was too cold to drink the water produced by the filter, 8.7% said it was too early in the day to drink water or that because it was so early they just had not gotten around to drinking water, 17.4% said that they were just not thirsty yet (N=23).

When asked about cleaning their filters, 27% of participants cleaned their filters since the investigator's last visit, but 73% did not (N=49). Of those who cleaned their filters, 33% used tap water, 33% used boiling water, 8.3% used filtered water, 8.3% used a brush on the filter, and 8.3% used soap on the bucket (N=12). Regarding usage, 87.5% of participants filtered water once per day, while 12.5% filtered water twice per day (N=48). Ninety-eight percent of participants were still as satisfied with filters as they were when the investigator had last visited and all respondents claimed that the filters

produced enough water for the family. All respondents claimed to be satisfied with filters, though 2% of respondents said they were “somewhat satisfied.” Only 8% of participants had any problems with their filters (N=49). Problems consisted of breakage with the filters or leaking or broken taps. The majority of participants found the filters easy to use.

Ninety-three percent of participants found the filtered water’s taste to be excellent when compared with the previously used drinking water, while 6.1% thought the taste was no different (N=49). Ninety-four percent of participants found the appearance of the water to be excellent when compared to the previously used drinking water, while 6.1% saw no difference (N=49). About 81.2% of participants thought the smell of the filtered water was excellent when compared to the previously used drinking water, while 18.8% smelled no difference in the filtered water (N=48). All respondents and the members of their households were reported to have been continuing to drink the filtered water.

Final Visits

The final visit to participants’ households was used to continue gathering data about filter usage and to also obtain feedback from users regarding their perception of the filters. All participants had used the filters during the previous week and the day before the investigator visited them in their home. On the day of the visit, 46% of participants did not use filters (N=46); of those who did not use the filters yet (N=19),

84.2% claimed that the weather was too cold and made them not want to drink water, while 10.5% claimed they were just not thirsty.

The daily usage of filters increased since the previous home visits. Forty-eight percent of respondents claimed to be filtering water once per day, 39% filtered twice per day, 11% filtered three times per day, and 2% filtered five times per day. All respondents claimed to still be satisfied with the filters and said that they were able to produce enough water for their families with the filters. Eighty-nine percent of participants did not clean filters since the last visit, while 11% of participants did clean their filters. Of those who did clean their filters (N=5), 20% used boiling water, 40% used soap on bucket, and 40% were unsure of how the filter and receptacle bucket were cleaned because another family member cleaned them.

Notably, no respondents reported any family members being sick with diarrhea since the previous household visits (N=47) and all participants were satisfied with the time it took water to flow through the filters, though 4% said they were *somewhat* satisfied (N=47). Overall, all respondents said they were satisfied with their filters citing the following reasons why: 9% were satisfied with the filters because they worked well, 2% said using the filters made them want to drink more water, 9% said filters were easy to use, 32% said the filtered water was safer to drink, and 36% said the quality of the water was improved (N=44). When asked later, all respondents said the filters were easy to use and that the filtered water's taste and appearance were excellent when compared with the water they had been drinking previously; only one respondent claimed there was no difference in smell between the filtered water and water they had

been drinking before they began using the filters. Only 4% of respondents had problems with their filter since the last visit (N=47), yet all respondents said they would recommend the use of filters to friends and family.

Ninety-eight percent of respondents claimed that the ceramic filter was better than their previous method of water treatment. When respondents were asked why they liked the filters, some of the following reasons were given: 30% said filters made water safer, 15% said its ease of use, 9% said the water quality improved, and 2% said filters reduced costs. However, when respondents were asked whether they would have considered buying a filter if they were not given one for the study, only 20% said they would have. Most respondents (72%) said they would not have bought a filter because most of them (76%) would not have known about the filters or their value and would not have thought to buy one. Respondents were then asked whether they would buy a replacement filter after the one year recommended use period ended and 98% of respondents claimed they would. When asked what respondents would like to see changed about the filter, 51.1% said nothing, 20% said to make it bigger, 4% said to include extra parts like a stand or clothe filter for very turbid water, and 20% wanted the top to fit on the filter better (N=45).

Other Results

Breakage

Determining the breakage rate of filters is a good method for determining the level of quality at which filters are being produced. A study conducted in Cambodia using the PFP model of filters found that 2% of filters break each month after

distribution (Brown, Sobsey et al. 2007). However, based on the number of broken filters throughout to the life of the study, the predicted breakage rate of the SWCEA filter is about 9% per month. Some breakage in the SWCEA filter is most assuredly due to user mishandling. Approximately 44% of discontinued filters were broken due to user error. Though solid, these filters are made of porous ceramic, leaving them susceptible to breakage. Users may drop filters while cleaning them, children may knock filter units over when playing in the house or while attempting to use filters, or users may cause serious breakage around the rim of the filter if trying to lift filters that have been filled with water.

Diarrhea Occurrence

As mentioned previously, SWCEA's goal in this project is to decrease the occurrence of diarrheal disease through the manufacture and implementation of ceramic water filters. In order to determine whether this project goal was being met, each participant reported at the time of their home visit by the investigator, how many people had diarrhea, whether it was a child five years old or younger, and for how long the diarrhea occurred.

At baseline, 10% of respondents had a family member with a case of diarrhea, three of which were children (N=50). Two of the children had ongoing bouts of diarrhea for approximately 14 days. 80% of cases at baseline were in Nambala. Upon the second household visits to each community, only one household in Sokoni and none of the households in Nambala had a case of diarrhea; this case was in an adult. Upon the third

visits, another household in Sokoni had a case of diarrhea in a child five years of age or under, which lasted for approximately one day. During the final visits to households, there were no cases of diarrhea reported. These results suggest that ceramic filters were effective in reducing diarrhea disease, however, results are not significant and there are other potential factors that account for this decline in reported diarrhea cases, which will be discussed later.

Focus groups

At the completion of the study, focus groups were held in Sokoni and Nambala to gather further feedback about the filters and clarify phenomena reported in the surveys that may not have been understood by the investigator. Nine participants were present at the focus group session in Sokoni, though all 25 participants were invited. In Nambala, 15 participants were present, also despite 25 being invited to come. Many of the same themes were apparent in both villages. For example, many participants were unsure of how to wash the filters properly and how often washing was supposed to be done. It was discovered through the surveys that some participants had not properly cleaned their filters before they began using them, while some participants were cleaning their filters too often and not properly with boiled water. In the focus groups, participants said that the filters needed to come with instructions because some forgot how the filters were supposed to be cleaned and others claimed that they were not present at educational session and so they were never told how to clean them, instead

their husbands were present, but never passed the instructions along. Had filters been accompanied by instructions, there would have been less confusion.

Another major issue that resonated in each community was based around participants' beliefs that their water was unsafe paired with the lack of action towards treating their water. As discovered in the surveys, 66% of participants thought their water was unsafe, yet 62% of respondents said they never treated their water before drinking it. Participants were asked to explain this phenomenon and gave varying reasons for not treating their water. One participant claimed she did not boil water because when it is boiled over firewood, the water resultantly smelled like smoke, so when guests came over and ask for water, she felt that she could not give them the water because of the smell. A different participant echoed this, stating that boiling water on a kerosene stove also leaves a smoky taste in the water. Another participant said that locating firewood was a problem in her community, so they could not boil water even if they wanted to, and when she tried to use WaterGuard, the chlorine disinfectant solution, it gave her headaches, so she stopped treating water altogether. Other complaints about WaterGuard included the lack of sustainability, in that once participants ran out of tablets, they would have to go to town to find more and by the time they have reached home, the children have already consumed contaminated water.

The major solution proposed by participants to increase the amount of people who would treat their water was education. According to one participant, treating water

was never emphasized in their culture. When they were young, there were no taps to fetch water from, they simply collected water from streams and wells. So without education, people will continue to do what is culturally accepted. Before the study took place, participants equated clean looking water to being microbiologically safe, but learned that the appearance of water is not an indication of how safe the water may be. Unfortunately, due to lack if education, this is still a largely held misconception in both communities.

In order to educate and help more people see the value of filters, participants suggested that sessions be held in their communities, schools, and churches. At this session, SWCEA staff could educate the audience about the importance of water treatment and demonstrate how the filters work. Participants also thought having photos of the petri dishes with bacteria growing in them from their drinking water would be helpful. Many of the women at the focus group volunteered to provide their own testimonial at the suggested sessions. Participants also suggested advertising on the television and radio, specifically on the Saphina radio station.

Participants were asked to talk about what barriers SWCEA might face when trying to get more people to use the filters. Ironically, none of the participants found the flow rate to be an issue, stating that if people just fill the filter with water over night, there will be plenty of water ready for the next day, so slower flow rates were really not an issue. The price of filters, which was about 25,000 Tanzanian Shillings (about 20 USD), was problematic and participants in both communities voiced their concern over the

price of the filters. The majority of participants were agricultural and have unstable incomes, being that they depend solely on the profits from their crops which fluctuate from month to month. Spending 25,000 Tsh on a filter is unrealistic for most participants and in some cases, more than the total income they may bring in, in one month. Participants requested that SWCEA reduce the cost of the filter to make them more accessible for those who actually need them but cannot afford them. It was also suggested that SWCEA implement an installment plan where people can invest smaller amounts of money until they reach 25,000 Tsh.

Overall, participants were very pleased with the filters and explained that the tap water had a muddy and salty taste, which was still present even after boiling the water. The filters, however, got rid of the taste and left water much lighter. Since using the filter, participants noticed a difference in their health and the health of their families. Specifically, participants said that the stomach problems they faced before were no longer a problem and the money they used to spend on taking their children to the hospital could now be spent on other things. Overall, participants were gracious for the filters and claimed they would continue using them, as well as encouraging others to treat their water.

V. Discussion

As a result of the study, it was found that participants accepted the filters well. They preferred the filters to their previous methods of water treatment and thought the quality of the water was greatly improved by the use of filters. The main barrier to filter use was its cost; this sentiment was echoed in both communities. There was confusion among participants about how and when to wash the filters, as many were washing filters too often or with contaminated water. Some participants began using their filters before washing it, thereby putting themselves at greater risk for diarrheal disease. Despite high acceptance of the filters, quality control for the filters was inconsistent and poor, thereby leading to the inconsistent flow rates and higher rates of breakage.

Water quality testing showed a decline in the amount of *E. coli* found in filtered water when compared to drinking water participants consumed before the use of their filters. After filter use, households fell within lower *E. coli* risk ranges indicating that filters were making water safer by reducing bacteria. Turbidity was also reduced by the filters, making water clearer, though most household's water was clear before filtering.

Survey results from respondents found that most study participants were knowledgeable about diarrhea, its causes, and ways to prevent diarrheal incidence, however, not all participants took the appropriate actions to prevent diarrheal disease like washing their hands regularly with soap or treating their water before drinking it. So though participants claimed to be using filters regularly, it is possible that their reported behavior does not mirror their actual behavior.

Recommendations

As a result of surveying participants and holding focus groups, it is my belief that social acceptability of filters will not be a problem in this rural setting. However, before any filters are sold, fundamental problems surrounding the production of SWCEA's filters must be reconciled. Filters need to have consistent flow rates and prevent the passage of all bacteria, specifically *E. coli*, if SWCEA expects to begin widely distributing and selling filters. If consumers are to replace their current method of water treatment, they should only replace it with one that is more effective. If effectiveness of filters is questionable, then consumers should not risk their health by purchasing filters at the prohibitively expensive cost of 25,000 Tsh.

Since the conclusion of this study, Tracy Hawkins of SWCEA told the Principal Investigator that a staff member from Agua Pure in the Dominican Republic traveled to Tanzania and helped reconcile the problems with quality control at the filter production center. Water samples from filters were tested at a local medical laboratory and showed that they were working at preventing the passage of coliform and *E. coli* into the filtered water. SWCEA may also want to consider selling all the supplies one would need to care for a filter as one package that would be included with the filter. For example, it is crucial that instructions are included with filters, however, if a brush and soap were included for cleaning the filters, there may be an increased chance that filters and receptacle buckets were cleaned correctly.

If the quality of the filters has improved to the point where they are fit to be sold, a marketing strategy will need to be developed to inform potential consumers and organizations about the benefits of filters' use. Potentially, NGOs and other large organizations may find it beneficial to make a mass purchase of filters that can then be sold at subsidized rates to potential consumers. Therefore, SWCEA needs to continue locating NGOs and other organizations who may be interested in working together to distribute filters. Advertisement for filters could be done over radio or television, like suggested by focus group participants, and by word of mouth at women's group meetings, church functions, community meetings, etc. to build demand for filters. Once demand for filters increases and SWCEA has enough capital, the organization should consider expanding their facility, as well as reaching out to other cities in Tanzania by conducting educational sessions where potential consumers can learn about the importance of water treatment and how ceramic filters work.

As shown in this study, when implementing a technology into a community, research should be conducted to determine under what conditions the technology can successfully be implemented. Better implementation practices should include researchers investigating the culture of the community to understand the hierarchy and disparities that may exist in it. The intended user should be investigated to determine their knowledge, attitudes, and beliefs, specifically as it relates to the technology researchers want to implement. Researchers need to ensure that the technology is a sustainable and suitable replacement for users' previous technology and should include consideration of the users' financial situation, culture, and beliefs. If these steps are

taken, researchers should gain beneficial information allowing their technology to be implemented more effectively.

Limitations

There were some limitations to this study that may have affected the study's outcome. In order to show more significant results, a larger sample size would have been needed, however, due to the time constraints of the investigator and feasibility of the investigator to conduct daily visits to participating households, the sample size of 50 participants was chosen. Also, while conducting these visits, it was necessary to have a translator present to assist the investigator with communicating to participants and vice versa. Because the investigator did not speak Swahili and the translator did not have a background in behavioral research, communication was a challenge and it is suspected that details that may have been useful to have were lost in translation. Unfortunately, due to the lack of resources, a translator knowledgeable of behavioral research could not be hired.

Surveys were read aloud to the participants of the study in case the respondent was illiterate or of low literacy. Their responses were then recorded by the investigator. Because of this, there is the possibility that respondents succumbed to issues of social desirability, where they withheld answers to seem like a better participant or to give the investigator more positive feedback despite their true experiences. This could be evident in the reporting of diarrhea occurrences; very few people reported experiencing

diarrhea, despite extensive research showing diarrheal disease to be an endemic health problem in sub-Saharan Africa.

Time constraints served as a limitation to this study in that initially, a goal of the thesis was to provide assessment-based community education about the importance of water hygiene, safe water storage, and household ceramic water filters; however, once in the field, it was realized that the planned training was not feasible for the population. Time constraints were placed on researchers due to the cultural roles participants had which limited their time to meet. Therefore, participants did not receive an assessment-based education to ensure that they fully understood the importance of water hygiene, safe water storage, and household ceramic water filters. Despite the time constraints, topics from the session were still discussed, though less in depth, in the initial meetings at each village.

Another limitation faced in this study revolved around the production of the ceramic filters. The scope of the study was changed because filters' quality did not meet the expectations of the investigator. Flow rates of filters were inconsistent, leading to uncertainties about the effectiveness of the filters. Had better quality control measures been put in place beforehand, the study may have had more significant findings. Proper flow rate testing and microbiological testing should have been conducted on the filters before they were given to study participants. This would have required SWCEA to produce more batches of filters than they had originally done; unfortunately, this also

would have required more resources, which were unavailable, thus preventing this from taking place.

Future Research for Emory Students

Students at Emory University who desire to work on research projects involving ceramic water filtration should contact Tracy Hawkins of Safe Water Ceramics of East Africa or Lisa Ballentine of Agua Pure to first determine what their immediate needs are. Both Filter Pure organizations should consider hosting student researchers to pilot and sustain a longitudinal study to gather more information about the long term use of filters. As mentioned, filter breakage is an issue that prevents filters from being used for an extended period, so it would be beneficial to follow up with recipients and consumers of filters after six months, one year, etc. to determine if filters are still being used and if not, why their use was abandoned.

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Annex A: Initial Survey

INITIAL QUESTIONNAIRE

Date of Interview	Interview Began	Interview Ended
__ __/__ __/__ __	__ __: __ __ am/pm	__ __: __ __ am/pm

Name of Translator: _____

Language of Interview:
(circle one)
Swahili
English
Other _____

"Hello, my name is Ansley Lemons. This is _(translator's name)_ . I am conducting research to improve the way filters for treating water are put into use by asking your opinion on a few questions. I am a graduate student at Emory University in America and _(translator's name)_ is an employee of Safe Water Ceramics of East Africa (SWCEA) here in Arusha. We have a method of water purification we would like to have you help us evaluate. This method involves ceramic water filters. I am conducting a survey and would like to talk to you about the water you use and how the quality of the water affects your health. I would like to talk to the man or woman of this household that has a child under the age of 6. Everything that you tell us will be kept confidential."

Household Information/ Demographics

1. Respondent's Name

2. Respondent's Status in Household (ONLY ONE RESPONDENT)

Father	1
Mother	2
Grandmother	3
Grandfather	4
Other:	88

3. Age of Respondent (estimate is acceptable): __ __

4. Sex of Respondent: (DO NOT ASK)

Male	1
Female	2

5. Did you go to school?

Yes	1
No	2

6. Can you read?

Yes	1
No	2

7. How many years were you in school (estimate is acceptable)? __ __

8. How many people live in your household? __ __

9. How many children are under the age of 6? __ __

10. Household's total monthly income (estimate acceptable): _____

11. Did anyone in your household have diarrhea last week (past 7 days)?

Yes	1	
No	2	Skip to question 14

12. If so, how many people? _____

13. How many days did the diarrhea last for each person?

Person 1:	_____ days
Person 2:	_____ days
Person 3:	_____ days
Person 4:	_____ days
Person 5:	_____ days

14. Did any children in your household under the age of 6 have diarrhea last week (past 7 days)?

Yes	1	
No	2	Skip to question 16

15. How many of the children under age 6 had diarrhea last week (past 7 days)? __ __

Household Problems

16. Can you tell me about the biggest problem your family faces? (DO NOT READ, WRITE ONLY ONE ANSWER)

Poor Health	1
Insufficient quantity of food	2
Poor quality of drinking water	3
Lack of money to meet basic needs	4
Unemployment	5
Homelessness	6
Lack of access to hospital/ medical facility	7
Other:	88

17. Can you tell me about the second biggest problem your family faces? (DO NOT READ, WRITE ONLY ONE ANSWER)

Poor Health	1
Insufficient quantity of food	2
Poor quality of drinking water	3
Lack of money to meet basic needs	4
Unemployment	5
Homelessness	6
Lack of access to hospital/ medical facility	7
Other:	88

18. Can you tell me about the third biggest problem your family faces? (DO NOT READ, WRITE ONLY ONE ANSWER)

Poor Health	1
Insufficient quantity of food	2
Poor quality of drinking water	3
Lack of money to meet basic needs	4
Unemployment	5
Homelessness	6
Lack of access to hospital/ medical facility	7
Other:	88

19. What are the most frequent diseases in your community? (DO NOT READ, MARK ALL ANSWERS)

Diarrhea	1
HIV/AIDS	2
Malaria	3
Trauma (injuries, mutilations, accidents)	4
Respiratory Diseases	5
Anemia	6
Skin Diseases	7
Other:	88
Don't Know	99

Knowledge about Diarrhea

20. What do you think diarrhea is?

21. What causes diarrhea? (DO NOT READ, MARK ALL ANSWERS)

Drinking dirty water	1
Eating contaminated food	2
Flies/Insects	3
Poor Hygiene	4
Weather	5
Spirits	6
Other:	88
Don't Know	99

22. How do you treat diarrhea? (DO NOT READ, MARK ALL ANSWERS)

Drink more liquids	1	
Drink less liquids	2	
Use salt packets (rehydration)	3	
Use sweet-salty solution	4	
Take medicine (antibiotic)	5	
Go to the hospital	6	
Do not treat diarrhea	7	Skip to question 25
Other:	88	
Don't Know	99	

23. When do you think you should begin treating diarrhea?

24. Where would you or members of your family go for treatment of diarrhea? (DO NOT READ, MARK ALL ANSWERS)

Hospital	1
Health Center	2
Private clinic	3
Pharmacy	4
Healers	5
Other:	88

25. Do you think you can prevent diarrhea?

Yes	1	
No	2	Skip to question 27
Don't Know	99	

26. How can you prevent diarrhea? (DO NOT READ, MARK ALL ANSWERS)

Wash hands more frequently	1
Cook thoroughly	2
Close/cover food	3
Boil water or treat it otherwise	4
Clean/wash dishes/utensils used for cooking	5
Other:	88
Don't Know	99

Water Use Practices

27. From where do you collect your water? (DO NOT READ, MARK ALL ANSWERS)

Running water in house	1	Skip to question 28
Private Well	2	Skip to question 30
Public Well	3	
From city supply	4	
River or creek	5	
Lake or Pool	6	
Hole in ground	7	
Vendor	8	
Canal or ditch	9	
Other:	88	

28. On average, how many hours per day is water available in your running water supply inside your house? __ __

29. Do you store water from your running water supply to use it for drinking?

Always	1
Sometimes	2
Never	3

30. How many times a day do you collect water? __ __

31. How long does it take you to collect water per day? __ __

32. What container(s) do you collect water in? (DO NOT READ, MARK ALL ANSWERS)

a) Metal buckets	1	Size (Liters)? ___ ___
b) Plastic buckets	2	Size (Liters)? ___ ___
c) Ceramic vessels	3	Size (Liters)? ___ ___
d) Small pans	4	Size (Liters)? ___ ___
e) Jerry can	5	Size (Liters)? ___ ___
Other:	88	Size (Liters)? ___ ___

33. Who usually collects drinking water? (DO NOT READ, MARK ALL ANSWERS)

Mother	1
Father	2
Older girls in the family	3
Older boys in the family	4
Daughter-in-law	5
Others:	88

34. Do you store water at home?

Yes	1	
No	2	Skip to question 42

35. What containers do you usually store water in?

a) Metal buckets	1	How many? __ __
b) Plastic buckets	2	How many? __ __
c) Ceramic vessels	3	How many? __ __
d) Small pans	4	How many? __ __
e) Jerry can	5	How many? __ __
Other:		How many? __ __

(ASK PERMISSION TO TAKE PICTURE OF CONTAINERS USED FOR STORAGE)

36. How many liters of drinking water are stored in every type of container?

a) Metal buckets	__ __ __ liters	Cover: Y N
b) Plastic buckets	__ __ __ liters	Cover: Y N
c) Ceramic vessel	__ __ __ liters	Cover: Y N
d) Small pans	__ __ __ liters	Cover: Y N
e) Jerry can	__ __ __ liters	Cover: Y N
Other:	__ __ __ liters	Cover: Y N

37. Approximately how many days do you store drinking water in your containers before it is finished? __ __

38. Do you use water from your containers for purposes other than drinking?

Yes	1	
No	2	Skip to question 40

39. What other purposes do you use this water for? (DO NOT READ, MARK ALL ANSWERS)

Cooking	1
Washing fruits and vegetables	2
Cleaning and washing of household dishes and utensils	3
Washing clothes	4
Bathing, washing of body	5
Other:	88

40. How do you take water from your containers?

Draw water with small pan	1
Pour directly from container	2
Draw water with a cup	3
Draw water with a scoop	4
Other:	88

41. Does anyone ever touch water in your containers with his/her hands when they draw water?

Yes	1
No	2
Don't Know	99

42. Do you think that the water you use at home is safe/clean to drink?

Yes	1	Skip to question 44
No	2	
Don't Know	99	

43. Why do you think that the water is unsafe to drink? (DO NOT READ, MARK ALL ANSWERS)

Water is dirty / turbid	1
Water is infected with microbes	2
Water contains larva, worms, etc.	3
Causes malaria	4
Other:	88
Don't Know	99

44. Do you treat water in any way before you drink it?

Always	1	
Sometimes	2	
Never	3	Skip to question 51

45. What do you do to the water to clean it?

a) Boil	1	How often?	Always……1 Almost always……..2 Sometimes……3
b) Filter through cloth, gauze	2	How often?	Always……1 Almost always……..2 Sometimes……3
c) Settle	3	How often?	Always……..1 Almost always……..2 Sometimes…….3
d) WaterGuard Chlorine Solution	4	How often?	Always……..1 Almost always……..2 Sometimes…….3
e) WaterGuard Tablets	5	How often?	Always……..1 Almost always……..2 Sometimes…….3
f) Other:	88	How often?	Always……..1 Almost always……...2 Sometimes……..3

46. Does everyone drink the water once it is treated?

Yes	1
No	2
Don't Know	99

47. Who drinks the water once it is treated? (MARK ALL RESPONSES)

Mother	1
Father	2
Children	3
Elders	4
Guests	5
Others:	88

48. Do you like the taste and smell of your cleaned drinking water?

Yes	1	
No	2	Skip to Question 50
Don't Know	99	

49. Why do you like the taste, smell?

50. Why do you dislike the taste, smell?

51. Before our meeting, had you ever heard of filters that you can use to clean your water?

Yes	1	
No	2	Skip to question 53
Don't Know	99	

52. What material was the filter made from? (DO NOT READ, MARK ALL ANSWERS)

Ceramic	1
Sand	2
Cloth	3
Other:	88
Don't Know	99

Household Hygiene/Sanitation

53. When do you wash your hands? (DO NOT READ, MARK ALL ANSWERS)

After using the toilet	1
Before meals	2
Before cooking/preparing food	3
After changing diapers	4
Other:	88
Don't Know	99

54. Do you use soap?

Yes	1	
No	2	Skip to question 56

55. For what purposes do you use soap? (MARK ALL RESPONSES)

Washing hands	1
Washing clothes	2
Washing dishes/utensils	3
Bathing	4
Other:	88

56. Where do you and your family bathe?

In a room	1
Indoor bath or washhouse	2
Outdoor bath or washhouse	3
Other:	88

57. Have you ever bought water for drinking?

Yes	1
No	2

58. If regularly purchased, about how much do you spend on water per month?

OBSERVATIONS (Don't Ask Aloud)

59. Is there a bathroom in the house?
Yes – 1 No – 2

60. What is the toilet/bathroom like?

Open defecation	1
Public Latrine	2
Private Latrine	3
Toilet	4
Other:	88

61. Is there a place for washing hands?
Yes – 1 No – 2

62. Is there any soap in the place they wash their hands?
Yes – 1 No – 2

63. Does the household have electricity?
Yes – 1 No – 2

64. Does the household have gas?
Yes – 1 No - 2

Test Results

Chlorine Residual:	+	or	-
E. coli:	+	or	-
Coliform:	+	or	-

Annex B: Weekly Survey

Weekly Questionnaires

Date of Interview	Interview Began	Interview Ended
__ __/__ __/__ __	__ __: __ __ am/pm	__ __: __ __ am/pm

Name of Translator: _____

Language of Interview:
(circle one)
Swahili
English
Other _____

Name of Respondent:

1) Did you use the filter last week (past 7 days)?

Yes	1	Skip to question 3
No	2	

2) Why didn't you use the filter?

3) Did you use the filter yesterday?

Yes	1	Skip to question 5
No	2	

4) If not, why?

5) Did you use the filter today?

Yes	1	Skip to question 7
No	2	

6) If not, why?

7) Did you clean the filter this week?

Yes	1	
No	2	Skip to question 9

8) If you cleaned the filter, please describe how the filter was cleaned.

9) In a day, how many times do you filter water?

1-2	1
3-4	2
5-6	3
7-8	4
9 or more	5

10) (IF WEEK TWO, skip to question 9) Are you as satisfied with the filter as you were last week?

Yes	1
No	2

11) Are you able to produce enough water for your family with the filter?

Yes	1
No	2

12) How satisfied are you with the time it takes the water to filter through?

1	2	3	4
Very	Satisfied	Somewhat	Not at all
Satisfied		Satisfied	Satisfied

13) Did you have any problems with the filter during this past week?

Yes	1	
No	2	Skip to question 15

14) Please describe what problems you had with the filter during this past week.

15) How easy is the filter to use?

1	2	3	4	5
Very easy	Easy	Satisfactory	Difficult	Very Difficult

16) If not easy (satisfactory, difficult, or very difficult), what makes using the filter difficult?

17) How would you rate the taste of the water after filtration in comparison with the water from your last method of treatment?

1	2	3	4	5
Excellent	Satisfactory	Same as previous method	Unfavorable	Terrible

18) How would you rate the appearance of the water after filtration in comparison with the water from your last method of treatment?

1	2	3	4	5
Excellent	Satisfactory	Same as previous method	Unfavorable	Terrible

19) How would you rate the smell of the water after filtration in comparison with the water from your last method of treatment?

1	2	3	4	5
Excellent	Satisfactory	Same as previous method	Unfavorable	Terrible

20) Do all the members of your family drink the filtered water?

Yes	1	Skip to question 19
No	2	
Other:	88	

21) Why do some members of your family not drink the filtered water?

22) Has anyone in your household had diarrhea since my last visit?

Yes	1
No	2
Don't Know	99

23) How many people had diarrhea? _____

24) For how many days did the diarrhea last for each person?

Person 1:	_____ days
Person 2:	_____ days
Person 3:	_____ days
Person 4:	_____ days
Person 5:	_____ days

25) Have any children under the age of 6 had diarrhea since my last visit?

Yes	1
No	2
Don't Know	99

26) Do you have any questions or concerns about the filter?

Yes	See below
No	

Questions/Comments/Concerns

Observations

Describe the condition of the filter (record breakage, cleanliness, etc.):

Test Results

E. coli: + or -

Coliform: + or -

Annex C: Final Survey

Final Questionnaire

Date of Interview	Interview Began	Interview Ended
__ __/__ __/__ __	__ __: __ __ am/pm	__ __: __ __ am/pm

Name of Translator: _____

Language of Interview:
(circle one)
Swahili
English
Other _____

Name of Respondent:

1) Did you use the filter today?

Yes	1	Skip to question 2
No	2	

If not, why?

2) Did you use the filter yesterday?

Yes	1	Skip to question 3
No	2	

If not, why?

3) Did you use the filter last week (past 7 days)?

Yes	1	Skip to question 4
No	2	

If not, why?

4) In a day, how many times do you filter water?

One	1
Two	2
Three	3
Four	4
Five or more	5

5) (If WEEK 2, skip to question 6) After using the filter during this past week, are you as satisfied with the filter as you were the last time I interviewed you?

Yes	1
No	2

6) Are you able to produce enough water for your family with the filter?

Yes	1
No	2

7) Did you clean the filter this week?

Yes	1	
No	2	Skip to question 9

8) If you cleaned the filter, please describe how the filter was cleaned.

9) Has anyone in your household had diarrhea since my last visit?

Yes	1	
No	2	Skip to question 12
Don't Know	99	

10) How many people had diarrhea? _____

11) For how many days did the diarrhea last for each person?

Person 1:	_____ days
Person 2:	_____ days
Person 3:	_____ days
Person 4:	_____ days
Person 5:	_____ days

12) Have any children under the age of 6 had diarrhea since my last visit?

Yes	1
No	2
Don't Know	99

13) Overall, how satisfied were you with the time it took the water to filter through?

1	2	3	4
Very Satisfied	Satisfied	Somewhat Satisfied	Not at all Satisfied

14) Overall, how satisfied are you with the filter?

1	2	3	4
Very Satisfied	Satisfied	Somewhat Satisfied	Not at all Satisfied

Why?

15) Did you have any problems with the filter during this past week?

Yes	1	
No	2	Skip to question 17

16) Please describe what problems you had with the filter during this past week.

17) How easy is the filter to use?

1	2	3	4	5
Very easy	Easy	Satisfactory	Difficult	Very Difficult

17a) If not easy (satisfactory, difficult, or very difficult), what makes using the filter difficult?

18) How would you rate the taste of the water after filtration?

1	2	3	4	5
Excellent	Satisfactory	Same as previous method	Unfavorable	Terrible

19) How would you rate the appearance of the water after filtration?

1	2	3	4	5
Excellent	Satisfactory	Same as previous method	Unfavorable	Terrible

20) How would you rate the smell of the water after filtration?

1	2	3	4	5
Excellent	Satisfactory	Same as previous method	Unfavorable	Terrible

21) Did all the members of your family drink the filtered water last week?

Yes	1	Skip to question 23
No	2	
Don't Know	99	

22) Why did some members of your family not drink the filtered water?

23) What did you like most about the filters?

24) What did you dislike most about the filters?

25) How does the filter compare with your previous method of water purification? Is the filter:

Better	1
Same	2
Worst	3
Don't Know	99

26) Would you recommend the use of a filter to your friends or other family?

Yes	1	Skip to question 27
No	2	
Don't Know	99	

Why not?

27) If we had not provided you with the filter to use, do you think you would have ever considered buying a filter to try?

Yes	1	Skip to question 28
No	2	
Don't Know	99	

If not, why?

28) When you are unable to use your current filter, will you buy a new one to replace it?

Yes	1	Skip to question 29
No	2	
Don't Know	99	

If not, why?

29) How much would you be willing to spend on a filter like the one you have been using?

_____Tsh

30) What would you change about the filter?

31) Do you have any questions or concerns about the filter?

Yes	See below
No	

Participants' questions or comments:

Observation

Describe the condition of the filter (record breakage, cleanliness, etc.):

Test Results

Chlorine Residual:	+	or	-
E. coli:	+	or	-
Coliform:	+	or	-

REMINDER!
Please attend the final focus group!

Annex D: Focus Group Transcriptions – Sokoni

Sokoni Focus Group Meeting – July 18, 2008

After passing petri dishes with bacteria grown from various water samples:

Omari/Ansley: Are there any questions? So it's very important to treat your water before you drink it.

Subject: I've got a question. You said we have to wash the filters after 3 months and then after 3 months is there any bacteria that can survive in that water [water in receptacle bucket?]

Omari/Ansley: The water that flows thorugh the filter, the filter reduces bacteria. The water in the receptacle bucket, it may still have bacteria, but it will be much less than what you poured through the tap. If you clean the filter correctly, most of the bacteria should be gone. There are many filters in Sokoni where there is no bacteria in the water because they were cleaned properly, so it's all about maintenance of the filter.

Subject: If you wash the filter before 3 months, is there any problem?

Omari/Ansley: As long as you wash it with boiled water, it's ok. Just don't wash it too much because it wears down the filter. Other questions?

Subject: You said we have to wash [the filter] with boiled water just [on the] outside [of filter]. Is there any problem to wash inside [of the filter] with boiled water?

Omari/Ansley: It's most important to wash the outside because that's where the clean water is. The inside will always be dirty.

Subject: The outside part is so very important to wash with boiled water than the inside part because the outside part is where water flows. The inside part is the place where the contaminated, dirty water is.

Omari/Ansley: Ok, so I have a question. Um, in the beginning, when we asked you if you thought your water was safe, many people said no, and then we asked, 'Do you treat your water?' and most people said no, so I just want to know why do you take the risk of not treating the water if you don't think it is safe?

Omari: Did you understand?

Subject: (all in unison) Yes

Subject: Others were treating through boiling or sometimes using Waterguard because we know for sure that the water is not safe and there is no other place we can fetch water that is safe so that you can drink in the time because all the water surrounding us were the water that needed to be treated.

Omari/Ansley: But there are some that did not do anything and they said they just drink the water from the tap (pause)…yeah, and they know it's bad but they do it anyway. Why?

Subject: I'm saying that I didn't even boil the water. I'm saying for sure that I have been washing my bucket with soap only and fetching water from the tap and then for the next day I pour them or can use them for other purposes and then I can fetch another one. I'm telling you lies if I said I've been boiling the water. I just assure you I've been using the tap water without boiling?

Omari: Why don't you boil them?

Subject: I don't use those practices [of boiling water]. I drink the water from the tap as they are… (pause)… One day, I boiled the water, then they smelled [like] smoke from the firewood, so even when the guests came I cannot give that water. I decided to pour them out. Then I decided to continue to use the water from the tap. Then I continued to pour them for the next day. Or if I didn't pour them for the next day, I pour them on the day after tomorrow because if I use the water which smells [like] firewood, I feel if the gas of smoke comes out. But I'm thanking God because there is no problem with my water, no even children of mine have gotten sick, or even any problem. So I'm very thankful.

Omari/Ansley: Karibu. (You're welcome.) Any other questions?

Omari: You just say what you're thinking about it or what you have on your head.

Subject: Since that day I received the filter, I was so very thankful. My water were very clean, no problem with them, I'm using it [the filter] well and my children are happy with it. The person that makes the filter, may God keep it up him in a good place. Even my neighbors, they just come to my home to ask for water for drinking and they are so happy to use the water from the filter.

Omari: Anyone who have comments or suggestions?

Subject: We have been using those water without boiling for so long and we have seen their effects and their bacteria so there is no bacteria in our stomach?

Omari/Ansley: Well…the…you will always have bacteria in your stomach, there is bacteria in your stomach, there is bacteria in your stomach from your body but the water you drank before, it will not affect you. If it has not affected you now, because usually if you drink or eat something that is contaminated it is instant when you get sick or it will be in a day or two and you will know what you ate or drank. So if you have not been sick recently, you should be fine. So just be careful today (laugh).

Omari: Another one? Suggestions? Why did you say you weren't treating your water?

Subject: Others know that the water is not safe, but they are saying that God will protect us so that we may not get sick.

Omari: You mother?

Subject: I'm saying that the problem which makes us not to boil water is the case of firewood. We don't have firewood. We like so much to boil… We like to treat our water even sometimes to use Waterguard and sometimes if you use Waterguard, it will make our head ache and that's another problem which makes us to stop treating our water.

Subject: What I can see, what stops us to treat our water is that sometimes you need the medicine [Waterguard tablets] but you meet that you late and the children are thirsty, so they use the water from the tap without being treated. Sometimes it is difficult for us to prepare the water like you have prepared them. [Subject referred to the time she spends going to town to buy Waterguard, the children, in the meantime, have already drank the contaminated water].

Subject: I don't even know what to say…

Subject: We are very thankful for having the filter. For me, my children were not used to drink water [before she received the filter] but now they like to drink water from the filter. For myself, I thank God. Even my neighbors keep coming to have the water from the filters for drinking.

Omari/Ansley: Can you ask them for me (to Omari), so what should we tell people to get them interested in the filters because their neighbors, they know now because they've used the filter, but other people, they don't know about the filters, so what can we tell them to make them interested and make them want to treat their water and not use the tap water?

Subject: You have to put it on [the] radio so everyone can hear about it, so that when any turns on the radio, they will hear about it because everyone when hearing about it, it will help.

Subject: Where can we get them [filters]?

Omari: Ngulelo

Subject: We, as Africans, the way we used to grow since we are young our parents were not boiling the water, there were no taps, we just used the water from the streams and wells. So the habit of treating water was not there. The way to help people as they are on their way of gaining education is the way they can use to treat water. Our tradition's habits were not treating the water even when we went to the Masaai people, they just dug wells and drank the water without treating. That the big problem which is facing us now.

Omari/Ansley: So, how do you change people's traditions? How do you change peoples' minds about why it's important? What message should we tell them?

Subject: We try to make them understand where they can get filters. When the guests came, they ask questions about the filter. I think they will learn slowly. Even in schools, we can educate then children about the importance of using filters. Even in books, they have written the only way to treat water is through boiling. So, when we impose the uses of filters as another way to treat water without boiling… Even at churches, you can

make them understand that will help. I'm asking that, is there any possibility for you to hold a seminar through a village meeting? So that we can [all the women] be together?

Ansley: Probably… that is a possibility because I have a curriculum that can help educate and will help them (to Omari). I'll leave it with you and Nnko and David.

Subject: Even through village after village or churches. Those are ways [that] will help people to understand well about the filter.

Subject: I was saying, there are some people [that] like the filter but when you tell them the price of the filter, they are saying that the price is too high. So how can you help those people so that they can have filters?

Ansley/Omari: We are trying to get more funding to help reduce the costs but until the funding comes, the filters will be 25,000 shillings, however, you should ask them, 'how much do you spend on medicine or going to the hospital when you go if someone gets diarrhea?' How much do you spend on firewood? How much on Waterguard? How much on all the dishes you have to boil water in? So it may cost more but in the end, it will save you money, so… and it lasts for a year.

Subject: How much is it?

Omari: 25,000 Tsh

Ansley/Omari: And tell them since they have the bucket, after a year, all of their filters were provided for free, after a year when they have to buy a new filter, if they keep the bucket, they will only have to spend 15,000 tsh for the actual filter.

Subject: Because you have the bucket. So it's just the case to buy the filter only.

Ansley/Omari: The bucket is 5,000 and the tap [on the bucket] is 5,000.

Subject: No problem.

Omari: Other questions?

Subject: I was asking that, as they have said, you just continue to recommend people so that they can have filters because they have seen how they work for us and they feel to have the filter in one minute. So that to cure the disease immediately is all people to have the filters.

Omari: What can we do now?

Subject: Just keep insisting [to] the people.

Subject: Another thing that will help other people or a person to have the amount of money … is a problem. It's better in your organization/group to choose someone who will be there so that he can collect the little payment from the people until they finish their payment and then give them their filters because for other people, they cannot afford to pay that amount of money in the right time. So to pay it slowly, slowly, slowly, slowly 25,000 tsh will be paid and then the problem is solved.

Omari/Ansley: Explain again… it's better for who to get the filter? Like to give them the filter and then just let them pay in little pieces at a time? That is good, but we just have to make sure everybody will pay because in the end, the materials, they cost. The silver that kills the bacteria is very expensive and it comes from the U.S. , so we have to get it in bulk and ship it here. The taps also come from the U.S., so they have to be shipped in bulk or people have to bring them here. So, that's ok, but in the end, we have to make sure that the costs are covered. And so, well, we just have to make sure our costs are covered.

Omari: Yes, it is possible, but it depends. We need someone we can trust to collect that money. We can't do it for some people and some people will not pay it and it will be a debt.

Subject: They won't pay it for a time.

Subject: It's better if you try to reduce the amount of money because some of them, they don't have and some of them have so look for it. Some of us, we depend on our farm and sometimes our farm doesn't give us anything so we stay without anything.

Omari/Ansley: Well, tell them I am not a business person, but I will tell them [SWCEA] what you all said. We're trying to make it cheaper because we know not everyone has 25,000 or 15,000 to spend on a filter. You're not thinking about a filter, you're thinking about food and getting your children to school, school fees, and you have other things to think about and other things to spend money on and we understand, so we are trying very hard and we have people in the U.S. who are trying very hard to get funding for Twiga [Pottery Center] to reduce the costs. So, we are working, we don't forget about you.

Subject: Thank you very much. May God bless you and greet them!

Subject: Hey, I was asking that. Is it ok if you can use the filtered water for other purposes like washing fruit, our hands, and home dishes because if you use the water from the tap to wash the home dishes and to clean with them, they will [get] contaminated with bacteria. Don't you think that it's better for us to use the filtered water.

Omari/Ansley: It is better than the tap water… So the filter is yours. You can use it as much as you want. I would use the filtered water instead of the tap water for washing dishes instead of the tap water for washing dishes, instead of the tap water for cooking and whatever else you would normally use water for, just use the filtered water… Other questions? I know you have questions?

Subject: If you take the water, are the rain water safer than the tap water?

Omari/Ansley: How do you fetch rain water? Where do you put your bucket?

Omari: On the iron sheet.

Ansley: You put it on top of the roof?

Omari: Down there, so they put them like lines which direct water [to their buckets].

Ansley: So it [the water] rolls from the roof to the buckets? So rain water is clean except when it contacts the roof or when it contacts something else that is dirty and that will contaminate the rain water. If you have a bucket and you just stand outside with the bucket over your head, assuming the bucket is clean, that would be ok. But that is not how it is usually collected and then you also have to worry about the watoto (children). If they go get the bucket , [and] their hands are not clean, they will also contaminate the water. So…

Subject: If they had not touched it, is it ok?

Omari: Yes

Ansley: So let's think, what else is in the sky? You have birds flying and they have, they use the bathroom… bugs, you have bugs flying, they're on the roof, so, your water is touching the roof where all these other things are, it's not clean anymore.

Omari: Other questions?

Ansley: So are there any challenges with the filters? Things that you think other people might find difficult if they don't have someone explaining step by step? Does that make sense?

Subject: Reduce the costs.

Subject: Through meeting.

Subject: Through churches.

Omari: Other than those ways, are there other ways we can challenge people to have the filters?

Subject: Through mass media – radios, television. So all over the country, even the world, they can have the news.

Subject: Many people want to see it. They will have more challenges.

Subject: Another way which I want to tell you is that maybe you have just started this factory in Arusha or another place out of Arusha. I think the better way is that, it will be good if you keep doing the same program as you have done to us. That way they will help people to know fast about filters. It is difficult to challenge people about the thing which they don't know. When they see it, the way it works, and the way it gives out the water and the way you keep using the water, it will help people to be more excited about the filter than to hear about it on television and radio.

Subject: It's ok if you choose another region like Kilmanjaro or Tanga. That will help the people to know much about the filter. Then it will be easy for the few of the people from Arusha who know about the filter to challenge the other people from Morogoro and Mbeya to know about the filter and that will be the easy way to let them know.

Ansley: We definitely want to do that. So when we have more and more filteres, we want to expand and get more people, so that is a good comment… Rather than coming to the workshop, is there another way to distribute the filters?

Subject: Is it the place where you are selling in Ngulelo? Is it along the road? Or elsewhere because I didn't see it.

Ansley: Tell her, the filters, you know, they're behind, but the shop is off the road so you can see that.

Subject: If you can bring [it] here, it's ok. Because it's something [of] quality, someone can come there. Even if he or she has 5,000 tsh, [he or she] can bring [it] there and leave it and [come] back on another day and finish the money which remains and then have a filter.

Ansley: Ok

Omari: Another?

Subject: For me, maybe, if we can have your number when someone needs it, so I can call you and you will bring us the order from the people.

Ansley: (to Omari) Um, I meant to ask, so maybe we can leave your number and we also need the chairperson's number so we can call the chairperson, but we can leave Kim's number and then have them call and we can send updates.

Subject: Ok

Subject: When someone needs [a filter], we can call you.

Omari: That is an easy way. More questions?

Subject: If you put it in the radio, many people can know easily. They must find where it is.

Ansley: Is there a certain station? I don't know radio here.

Omari: There are certain stations here.

Ansley: Is there one that most people listen to or is there one that young kids, or … who, which station?

Subject: Many people listen to Safina radio station.

Subject: Saphina

Subject: Saphina

Subject: Saphina station, many people were healed through prayer and there are many number of people who listen to Saphina and they have information immediately.

Subject: Especially on Sunday morning and evening.

Subject: When you announce stuff like that, they will have to listen and have the information on Sunday and that is the day where many people listen to that station.

Subject: When you put the announcement on the radio station like other announcements they will have information.

Ansley: Now, the filters that get sold, they have to flow within a certain range. They have to give 1-3 liters per hour of water and so the filters that flow [at] 1 liter, it's kind of slow, but do you think that, that will have an effect on how people like the filters? Do you think how long it takes the water to flow through will make people not want to use the filter anymore. Will they still use it because they know that it is safer than the tap water?

Subject: No problem for that.

Ansley: And most of theirs, they flow between the 1 and 3. Some are a little faster, none are less than that, so theirs are about what would be sold… Are there any other suggestions about how we can make the filters better and get more people to use them? Who should our audience be? Who should we be trying to get interested [in filters]? Should we go for the men or for the women? The young? The old? Is there… who is the audience for us?

Subject: The women

Subject: Women have more money than men.

Subject: The water from the filter and the rain, which one is good?

Subject: The water from the filter is better.

Omari: What can we do to motivate women to use the filter?

Subject: It is better for you to find the day and then inform the chairperson and the people had already heard about the announcement form the radio. And then when you inform the chairperson which day we can hold he seminar and invite all the women, those who know about the filter and those who don't know about the filter and then it will be easy to challenge them through meeting. When they go back [to their homes] they will recommend [the filters to]those who were absent.

Subject:

Omari: Out of radio, how can we use women to recommend about the filter? What can we do?

Subject: Through meeting and invite all women

Subject: Insist the subdivision chairperson to remind all women and to all women [who] surrounded his boundary.

Subject: Only women even to inform chairperson to remind all women to come to the meeting and recommend his subdivision's leaders to invite all women.

Omari: You said something, what's that?

Subject: I forgot.

Ansley: So, if you could tell one person who knows nothing about the filter, they don't know about treating their water, they drink their water from the tap. If you could tell them one thing to change their mind what would you tell them?

Subject: I would like to say on the day of the meeting, you have to bring the filter as an example. When they come, you have to make sure it has water in it, because they will ask where is it now, then we can see. Even us, we can bring it. And then, you can show [them] how it works and what [the] water looks like.

Ansley: If they [the participants] have someone to talk to who had no idea what the filter was, they had never treated water, they drink the water from the tap and they wanted to change their mind and get them to use the filter, what would they tell them? What would be their message to that person?

Subject: We can explain to them.

Subject: On the day when you invite women you will have to bring the sample [filter], as the woman said, then you can explain to them so everyone understands ,then it will enable [a] high percent of women to understand about the filter. So it will help for the attended women to split the information to the absent women who were not attended the meeting. That will be the good way to announce it.

Subject: Don't forget the sample of the bacteria.

Subject: Because we… I will be there and we will tell the people about it and then other people who don't have the filter will be interested due to the fact that they will say to themselves, 'why does this woman keep [talking] about it? Maybe it's good.' Then they will have the filter.

Subject: And don't forget the sample the sample of the water which you have taken from us.

Subject: Maybe because we have the filter, those people who are coming to our houses, we also explain to them about the filter. When they ask about the water to drink, we can tell our children, 'go inside and bring the filtered water.' Then he or she starts to ask 'What is [a] filter? How [does] it work?' And then we explain how it was, how does it work, and where they have been selling them, therefore, many people have already known about the filter and the filter is not something new to the people. The neighbors have already known about the filter through us, who have the filters. When you do it at another place again, it will challenge the people more about the filter. From us, now many people know what the filter is.

Ansley: Well, I just want to thank you all again and I won't keep you any longer. If there are any other comments, please feel free to give me feedback.

Subject: Before you announce, you have to do a meeting and invite all the women. Is that ok?

Subject: Yes, that is ok to invite all the women from Baraa (Ward) before you announce to the radio.

Subject: One of the men came to my house and asked for water to drink and then said 'Do you have a fridge?!?'

Subject: (laughter)

Ansley/Omari/Subjects: Thank you

July 16, 2008

(House 22)

Why do you think people don't treat their water if they don't feel it is safe to drink?

"They know the water is dirty, but they don't want to boil it, but it's our responsibility to boil/treat the water so it is safe to drink. It's much work to boil water. Even when I go far from home and there is no water, I just drink from the tap. There isn't education about the effects of untreated water. They think if the water is clean [clear looking], then it is safe. If they had education, they would boil [water]."

Annex E: Focus Group Transcription – Nambala

Nambala Focus Group - July 25, 2008

After passing around petri dishes of bacteria grown from water samples and explaining results:

Ansley: Any questions?

Subject: Is our water so dirty?

Omari: Yes, they're so dirty.

Subject: Why do some of the samples from the filters have blue dots?

Omari: Because you didn't follow the instructions which we instructed you [about washing the filters with boiled water to sterilize before using]

Nnko: When we told you 3 months, we have to make sure you boiled the water well, take the filter, pour outside and inside [the boiled water] and in the bucket. Wash it [the bucket] with boiled water too in order to keep the bacteria away.

Subject: How about the water from the tap. Sometimes they are dirty. What can we do about them?

Nnko: Where are they coming from?

Subject: The tap

Nnko: No problem with that. Or sometimes if they are so dirty, just filtrate [the water] with a piece of cloth and pour it in another bucket and then pour it in the filter… (to all) Have you started to [have] doubts about your water?

All Subjects: Yes (in unison)

Ansley: Questions? I know you have questions… no? … So seeing the bacteria, how does that make you feel about your water?

Subject: We feel very bad.

Subject: I see like my water has bacteria from the filtered one.

Ansley: So, in the beginning, when we came to your houses, we asked you if you thought the water was safe and some of you said no. And we asked if you treated the water and some of you said no. I just wanted to get an idea of why you don't treat it if you don't think it is safe?

Subject: We did not know if our water is not safe. When we saw our water was white [clear], we know that our water is safe and there is no problem with it. But now we know that the water we use from the tap is not safe, for sure.

Ansley: So you thought it was safe?

Subject: Safe

Subject: When we get them [the water] from the tap and we see our water is clean, then we know it is safe.

Ansley: But now you know just because it is clean, looks clear, does not mean that it is safe. They are different.

Subject: Yes

Ansley: So, I have a question about the filters. When we distributed the filters, we asked everyone to clean it by boiling the water, but many people used the tap water to clean the filters, so I want to make sure the instructions are understood by other people buying them so why do you use the tap water and not the boiled water?

Subject: Someone is forgetting to wash it with boiled water, it doesn't mean that we don't like to do it. The problem is we just keep forgetting. So the people just take the easy way to wash it with tap water. Other people received the filter, and we were not there, we were at home, so we were not told the instructions on how to clean it.

Subject: For the first day, we weren't told how to clean it with boiled water. We were just told to wash it safely and to fill water in it and wait until it flows through the filter and pour it out again, fill the water again, wait until it flows, and pour it out again, and fill the water again, wait until it flows and pour it out again. For the second time, when you visited us, you were the one that told us to boil water and clean it.

Ansley: So that was a problem with instructions. They should have been told boiled water the first time. Ok, so now they know… and it's clear?

All Subjects: Yes, we understood (in unison).

Subject: We washed the filter with boiled water continuously after you told us to clean it with boiled water.

Ansley: Ok, thank you… What problems do you think people may have with using the filters? Is there anything that seems difficult that should be explained better when people come to buy a filter? What problems might people have understanding how to use the filter?

Subject: It's not difficult to use the filter.

Subject: Maybe they don't know its importance.

Nnko: For example, if someone comes and tells you, 'I need a filter,' will you be able to tell them what to do about the filter?

All Subject: Yes (in unison)

Ansley: And can someone tell me now?

Subject: Yes

Nnko: Assume that this is the customer who wants to buy the filter from you. Explain to him how he can use it. Before you take the filter and you hadn't started to use it, what can you tell them? Like this or that and this, and this, 'in order to have safe water because the water has some bacteria,' which we have seen. Have you seen them?

Subject: Yes

Nnko: Explain now… Can you explain to them what it's about? Who can explain?

Subject: Firstly, you fill the filter with water and wait until it filtrates and pour them out and then you fill it again. Then, I boil the water to clean the filter. After you have washed it, you put the water to drink [in the filter].

Nnko: What kind of water?

Subject: the tap water

Subject: If that sister is coming to buy the filter in our organization, after she arrived we told her this is the filter which you can take to your home. When you arrive at your home, you fill the water 3 times to remove the smell of the filter by pouring the water out. After then, you have to put the water in the fire, about 10 or 20 liters. After they boil, you take the filter and clean it with boiled water through immersing it in the boiled water and then put the filter on the table. And take the bucket again and wash it with boiled water, with soap, and brush, and clean it again with boiled water to remove the foam. After you have washed the bucket, place it where it concerns. Take the filter again and put it in the bucket. After then, take the top cover, wash it the same as you have washed the bucket and then pour the water in the filter and take the top cover, just cover the filter and wait for the water to filtrate and use with your family. When you use that water you will see the importance of the cleaned water.

Nnko: She's good for representing Safe Water Ceramics of East Africa.

Ansley: Ok, very good.

Nnko: I think that is the better way to explain to the people. Did you hear?

All Subjects: Yes (in unison)

Nnko: And you too, you continue to do the same. You have already seen where the problem is. Don't just take the water from the tap and drink it.

Ansley: Please don't… So many people here [in Nambala] don't treat their water. What can we do? What can be done to get more people to treat their water before they drink it? What do they think is needed?

Subject: To educate us about the water from the filter and tell us where we can find the filter so that when we go back we can tell the people where they can get it. And the price, if it's 25, we can tell them it is 25.

Ansley: Anyone else?

Subject: I think to reduce the price of the filter because when we explain to them about the filter and tell them it costs 25,000, they are saying it is so very expensive.

Subject: There are some, when we were explaining to them, if there is a possibility to reduce the price because some of them say that they cannot afford to pay that amount of money. If there is a possibility to make it like a loan so that they can pay over time. To minimize the price about 12,500 [half] or maybe 5,000 for this time, another time 10,000, 5,000 again, so everyone can have the filter.

Subject: To educate them so they can understand by having the pictures of those bacteria and to show them. After then, to educate the people who don't have the filter that your water is clean or tap is clean and safe, say yes, they are very safe and then when you show the pictures of those bacteria and explain to him/her maybe he will stop using the water from the tap and buy the filter. If someone comes to your house and asks for water to drink, tell them 'Hello my friend, did you know the water from the tap is not safe?' or maybe someone is sick and suffering from typhoid and then you show them the picture of bacteria [and say] 'Just taste this water from my filter and look at the difference between the bacteria from the water and [the bacteria] from the filter. That will help attract people to buy the filter.

Nnko: So, if the filter is costing 25,000 and that day we say the water for Kilimanjaro costs 400, per one day, [how much] are you spending on bottles of Kilimanjaro?

Subject: No, we are not using [Kilimanjaro].

Nnko: But how many people are suffering from disease per month or year? Are there so many?

Subjects: Yes (unison)

Nnko: Do you take them to the private hospitals?

Subjects: Yes (unison)

Nnko: How much do you spend?

Subject: It depends on what type of disease.

Nnko: Just imagine if you have 2 or 3 children and they have been admitted to the hospital. How much money do you spend for these children? Is it not a lot of money?

Subject: Yes, 50,000…

Nnko: And the filter gives the water to many people. Everyone can drink it. It saves many people.

Subject: Yes

Nnko: If you have many children, they'll be cured. If you are saying 25 is a lot of money, don't you see these bacteria will come into your stomach again and again and will be there in the stomach of children too?

Ansley: What do they think is a better price? Would 20 be better? 15? How much?

Subject: You know that question is for you. You're the one who is going to buy the clay soil and everything and also due to the rising of fuel and transportation costs and the costs of the filter… for you, it's the amount which you see is better. But for people here, it is difficult to for them to pay 25,000 per one time because they have to go to the market to sell their things. Maybe this day, they have 2,500 from the market… it takes a long time to have that amount of 25,000. That's why we're saying to give the loan to the people and there are some who have agreed to pay 25,000, but to be in terms [installments]. After they have collected enough money, they can have the filter. There are some who are saying the price is higher and some of them say to make it 15,000, 20,000, and some say the price they want.

Ansley: We're still waiting to hear about funding, but we're trying to make the price lower.

Subject: Is it necessary for me to come to the factory when I have a customer?

Ansley: So explain to her that we're still working on [the filters]. We don't have them ready yet. We have to order more buckets and things. We'll leave a number and get the chairperson's number and contact them, but also tell them how to get there.

Subject: There are some who are saying 'How can we get the filters that are the same like yours?'

Ansley: They'll be ready soon. We're getting everything together now, so we will let them know. They'll know…

Omari: We are just working on it. The place where you can find the filter is in Ngulelo, but now we are doing what we can to make them ready. We will inform you in the village if they are ready and to get well prepared, but if you are of high number we can see if we can bring them to you or you can just come here [to Ngulelo].

Ansley: Other questions? … What can we do to get more people interested in the filters?

Subject: To get more people as I said, to have the pictures and when they are here, we can campaign. After then, we can show them the pictures so they will be interested.

Ansley: But how would we get them together to do that? Should we have a meeting? How should we do that?

Subject: Through meeting, that is ok. After that, you have to tell us the price and [take] the picture and distribute them to the people. They will be motivated to have the filter, and for us who have the filter already, we can give them the seminar if they ask about

the filter. To give the paper [the pictures] and to tell the people through meetings, it's not enough but when he or she meets me, I have the filter, I can explain to him or her more about it and add some words which will help him or her to be interested and then he or she can buy the filter.

Ansley: Now, for everyone to have a dish, I can't do that because I don't have enough for everyone. But pictures might be possible, we'll see. Other ideas?

Subject: Sometimes you can use radio, television, and newspaper.

Ansley: So, if a friend or relative came over one day and said 'What's that over there in the corner?' and they were pointing to the filter, what would you tell them to get them interested in using the filter?

Subject: Firstly, if it's my friend who asks about it, I can say that is my pot for water. 'How is it?!' If you tell them it is a filter, they won't understand you. You open for your friend and explain to them what it is and how it works. [The friend says,] 'There are others telling us to buy the special filters.' 'Don't listen to them, just keep it behind and buy this one because it filters water very quickly, so that I can tell him or her many words to split the jelly at the back of the bottle [to say many words to convince someone to have something] and he or she will realize they should have the filter.

Subject: No need to boil water and it saves time and it is very easy to use.

Ansley: What else would you say?

Subject: Even the boiled water, they are different than the filtered water and if you take the water from the tap and pour it in the filter and take the water from the tap and taste them, they're quite different in taste. You should tell that. You can give that water from the tap to compare to the filtered water (how it tastes).

Ansley: And what else?

Subject: Some of them, they are not boiling water with charcoal, they boil water with firewood and when you boil the water with firewood, it smells smoky. But if you taste the filtered water, it doesn't have any smell.

Ansley: So the charcoal doesn't have a smoke smell? Really?

Subject: Even the kerosene stove has a smoky smell and it tastes different from that of the filter.

Ansley: Tell me again, what is the difference in the taste of the water? The tap water compared to the filtered water? What does the tap water taste like and what does the filtered water taste like?

Subject: The tap water and the filtered water, even when you compare them, they are quite different. When you drink even now, the tap water, you will sense the smell of the muddy taste. But the filtered water has already lost the smell of the muddy taste. The water from the tap is heavy in taste and the water from the filter is light in taste. The water from the tap has a salty taste and it looks like hard water.

Ansley: And is the salt, that taste, is it the same in boiled water? If they boil the water, do they still taste salt?

Subject: Yes, it has [the salt taste].

Ansley: Even in the boiled water? So, the filter gets rid of all the tastes and [in] the boiled water, they still taste some of the tap? Okay.

Nnko: When we are passing by, we told you taste the Kilimanjaro [bottled] water and the filtered water. Did you taste them?

Subject: Yes, no difference.

Nnko: When you're going to the hospital, how you making sure you have safe water to drink? Are you taking the filtered water or you are just buying?

Subject: Yes, we're buying.

Subject: We are taking the water from the filter and going with it to the hospital.

Subject: We just take the water from the tap at the hospital and drink them.

Ansley: Did the filter meet your expectations? Did they expect the same results? Did they expect the filter to be better, worse? Are they satisfied? If so, how?

Subject: We are satisfied.

Ansley: It met their expectations? Why?

Nnko: When you were told about the filter, how did you expect it to meet your expectations? Those ideas of having the filter, now you have the filter, is it that what you're having now?

Subject: Yes, we have what we expected.

Ansley: And what did you expect?

Subject: To help our family

Subject: So that we won't go to the hospital

Subject: Since I first received the filter, I no longer had problems with my stomach, even my children… and I will not go to the hospital because of stomach problems. It doesn't mean I can't go to the hospital, but I can go because of another problem. Maybe eye [problems], or injury from something, or a wound, but not from stomach ache.

Subject: In a family there are so many diseases which the family is suffering from, but especially the problem of stomach, it is no longer there, even though there are other diseases which I can take them to the hospital for treatment, maybe like eye problems or else, but not for stomach ache. Even in my family, they are not suffering from the stomach diseases which are caused by the water or even the fevers. Even the money which I used to spend on curing the diseases, I just use them for other purposes.

Subject: Since I have received the filter, they have reduced the costs from boiling water. I was not worrying if I was late somewhere, no need of me to boil water and wait for them to cool, I just meet [the filtered water] there all the time.

Ansley: Any other questions/comments? Do they have comments? Be free…

Subject: I was very glad to have the filter. Before, I was not boiling my water. Even the time to boil them, I don't have. I just take the tap water and drink as it is.

Ansley: I'm glad that you like it… Does anyone want to just comment on the filter?

Subject: Make them fast, so that everyone can have the filters.

Subject: The top cover should fit over the filter.

Ansley: Yeah, is there anything else we should fix? A lot of people said they wanted the cover to fit over the full filter. Is there anything else? Are there any other changes that should be made? Any improvements?

Subject: The filter is no problem.

Ansley: So everything with the tap, the spigot that pours the water, that's ok? Everything works?

Subject: No problem.

Subject: Make sure that children do not keep touching the tap because their hands are dirty and it will make the water to be dirty too.

Ansley: Anything else? … Who should we target? Who should we focus on talking to?

Subject: Ourselves, who have the filters, will challenge people about the filters and also you can have many people who need filters.

Nnko: Out of those people who have the filters, what ways are we going to use to have many members? Can we use village leaders or church leaders? Or party leaders?

Subject: You can use village leaders like the chairperson or even teachers in the classes and pastors in the churches.

Ansley: Other ideas?

Subject: I was thinking that when they're having the meeting in the village, just to make sure the people who make the seminar are there and they can inform the chairperson of their agenda and then they start to tell the people about it. Because those people who are giving seminars are still there, they can stand in front of the people and tell them about the filter and start to say 'this is the filter which gives safe water to the people and this is how it works, and this and this, and this' so that the people would have the education about the filter.

Ansley: Is that something that they can do? They'll do it? That would make everyone's life much easier. Good. Any other ideas?

Subject: To have instructions and the pictures of the bacteria from the dishes.

Nnko: They're still insisting about the pictures.

Ansley: I'm going to try to…

Nnko: These things are dangerous to us. They're also in the water that we normally drink…she said she's still working on it, to take the pictures of the dishes. Especially to the office when you're explaining about the agenda of safe water, you can just ask about those pictures from the chairperson and you can just show these pictures of the dishes… and in churches also.

Subject: Even in churches

Subjects: Even in our groups in churches, we can just educate the people about how to use the filters and to buy them.

Ansley: Tell them we would appreciate that, if they spend the message.

Omari: In your village, do you have the women's group organizations?

Subject: Yes, that is UWATA (The Unity of Tanzanian Women –translated).

Omari: What do you think if we can use those groups because they say if you educate the women, then you educate all of society? So they can challenge other women who do not have the filters.

Subject: I'm one of the women's group members…

Omari: You as a women's group member, what will you tell those people who do not have the filters?

Subject: I can educate them on how to use the filters through seminars and its advantages and how to use it and how to overcome your budget in your family, no need to boil water, how to prepare water for someone who is sick and to take water if you are going to farm or doing work far from home, just take the filtered water, which is safe. You can explain how to use the water from the filter as an easy way rather than to boil water or to buy the medicine [Waterguard tablets]. Sometimes the medicines were not there in the shop, maybe they have finished it, but the filtered water is always there, 24 hours they are there in your family and you can use them as the way you want to use them. You can explain briefly how [the water] tastes, how it looks, and how easy it is to use. I don't think that will be difficult, it will be easy for her to buy the filter to use.

Ansley: If they don't have any other questions, we can let them go. Thank them again. Please have juice and cookies… tell them to help themselves. But ask if they have any questions.

Subject: Another thing, if someone asks where I can find the filter and which way I can use to get it, I think for me it's better if you leave your address to the village office so if we have a customer who needs a filter, we can just go to the chairperson and tell them that there are people that need filters and the village chairperson will inform you that you can bring it to them.

Ansley: So can we write your number on the board?

Nnko: So, I'll write the number of the one who makes the filters [Kim] and mine.

Ansley: If they want to write the numbers down… (passing out pens)

[Nnko is writing his phone number and Kim's phone number on the board in the room and participants are copying it down.]

Ansley: And also, we'll communicate with the chairperson and tell them when [the filters] are ready.

Subject: Make sure those numbers are yours so if we need to communicate with you [or] if we need the filters…

Nnko: We are the ones who are distributing the filters. Anytime you call my number or Kim's number, we can tell you everything that you ask for.

Subject: Where are you?

Nnko: Not far from Mnazareti. Do you know the Oil Station? Before this station, there is a big farm and after that farm that is where you can find us.

Ansley: Twiga Pottery Center

Nnko: If you get there, you will see the giraffe drinking water on the door of the building. After this building, there is Mnazareti station, then drop by there.