Water in Tanzania;  
A Role for Extension

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Abstract:

In an effort to examine household drinking water contamination, observations, interviews, and physical property tests were administered in the village of Olorien in Northern Tanzania during November 2004. Observations offered insight into behavioral incidence of polluting water resources. Simply not boiling water and using large containers for storage led to significant results of the occurrence of E. coli. Households with lower incomes were found to boil their water less than those with high incomes, which in return led to high incidences of E. coli contamination in low-income houses. It was also discovered that not a single sample contained chlorine which causes speculation that Arusha Urban Water Supply & Authority (AUWSA) is not properly treating the municipality’s water supply. Not only can original water sources not be trusted, but residents are in need of taking responsibility of caring for their supply. After the examination of one hundred houses in the village and twenty-two original water sources, it has been concluded that residents are in fact contributing to the contamination of their drinking water supply. With proper education of how to handle and store water carefully, residents can take control over their well-being and many lives may be saved.
Introduction:

Every fifteen seconds a child’s life is lost somewhere in the world to diarrhea, caused largely by poor sanitation and contaminated water (World Health Organization: 2003). Five million deaths occur every year due to water-borne illnesses, which could be reduced by half if proper access to safe water was available. (The Public Citizen: 2004). Though access to clean water should be a universal human right, it is still a major issue in developing countries.

The United Nations estimates that 1.2 billion people still lack access to a reliable source of water, while other sources note the number to be higher (The United Nations: 2004). “Reasonable” access as defined by the United Nations, is providing each person with twenty liters of water per day within one kilometer of their house (The United Nations: 2004). However, the World Health Organization (WHO: 2003) claims that at least twenty five liters is needed per day for basic human survival and one hundred liters per day is needed for sustainable livelihoods.

The United Nations is one organization aiming to reduce the number of people suffering from inadequate resources. In the recent 2004 Millennium Development Goals (MDGs), the United Nations has proclaimed the decade from 2005 through 2015 to be dedicated to Water for Life with the objective to halve the proportion of people worldwide lacking safe water (World Development Indicators: 2004). This means 1.5 billion people will need to be provided with access to safe water within the next eleven years. The World Bank sees this as difficult since “further growth in population and economic activity will add to the demand for water and by 2050 the share of the world’s population facing water stress could increase more than five-fold” (World Development Indicators: 2004). It is becoming more apparent each day that close attention and fulfillment of these goals is critical.

Sub-Saharan Africa is emphasized in many development goals, though it is an area that is struggling to achieve many development programs simultaneously. The State of the World’s Children Report (2004) has already concluded that universal access to water in sub-Saharan Africa will not be achieved until at least 2020. The report also suggests that other plans being implemented in sub-Saharan Africa could take one hundred years to complete. Though seemingly pessimistic, it was in 1990 that goals at the World Summit were set forth to bring universal access of water to all in Tanzania by 2000 (The Public Citizen: 2004). Seeing goals fail only suggests that a role for extension in the form of education, research, and outreach is needed. It is not only crucial that large organizations expend the effort to provide water to all, but that smaller partnerships in each locality work to set forth this extension as well.

Education regarding proper storage and maintenance techniques of water is currently lacking. Though such procedures are easy to administer, many residents are unaware of how to do so. For example, improper storage techniques led to outbreaks of Dengue Fever in India (World Health Organization: 2003). As people began storing extra water so as to help themselves during droughts, they created an ideal breeding environment for the disease. India, however, is not the only area on the globe lacking such information.

Tanzania, a country in sub-Saharan Africa, has a population of over 35 million people (Tanzania Government: 2004). Only forty-percent of the rural population and seventy-percent of the urban population have access to piped water (The Public Citizen:2004). The government estimates that eighty-percent of the population is living in rural areas, implying
that the majority of the population is lacking necessary access to water rights (Tanzania Government: 2004). In Tanzania alone, water-related diseases account for over half of all diseases affecting the population (Tanzania Government: 2004). Rivers and streams are often contaminated with trash and litter which gather on the rocks and reeds. The presence of such contamination creates ideal conditions in which water-borne illnesses can thrive. In 2001, the World Health Organization noted an outbreak of cholera in Tanzania after 109 cases were reported. Though Tanzania has an average annual rainfall of 800mm and lakes covering seven-percent of the land, water shortages still exist (Tanzania Government: 2004).

As the water supply continues to be depleted, corporations are using it to their advantage in an effort to gain profits while people are struggling to maintain control over their water resources. Currently, organizations and outreach programs are striving to eradicate disease, improve housing, raise education levels, and increase the number of people who have access to clean, safe water and sanitation. There is frequent questioning between the Government, private investors, and Non-Governmental Organizations (NGOs) as to the responsibility for ensuring citizen access to safe water.

In 2002, Dar es Salaam was forced financially by the International Monetary Fund (IMF) to adopt the privatization of water. Through rules and regulations of Structural Adjustment Programs (SAPs), privatization was the only option which offered funding assistance for Tanzania in an attempt to supply communities with safe water. Under the conditionality imposed by the HIPC (Highly Indebted Poor Country) relief program, Dar es Salaam Water and Sewage Authority (DAWASA) was initiated. The price for water impacted the poorest population as DAWASA aimed to ban the use of illegal water sources. Poor populations which are unable to afford the costs for a legitimate water source were left to use unsafe water sources instead.

Similarly, in northern Tanzania, Arusha’s water supply is under private ownership. The Arusha Urban Water Supply & Authority (AUWSA) is in control of all pipelines within the Arusha municipality. For residents, this means water comes at a price if the household is within city jurisdiction. Efforts to improve and clean up such areas are lacking though recently, in an attempt to clean up the city before Kofi Annan was said to visit, Arusha organized a task force to clean the city’s streams and riverbeds which were visible from the street. Surprisingly, the areas looked somewhat pristine compared to their usual appearance, but it only took one rain to wash more litter back downstream.

Many low-income residents are unable to afford access to stand pipes and therefore go to the banks of such rivers or small streams to collect their water. Menssary Kimaro, Officer of Water Quality at Arusha Urban Water Supply & Authority (AUWSA), stated that within the Arusha municipality chlorine (sodium hypochlorite) is pumped through the water supply daily as a disinfectant (personal communication 1: 2004). The properties of chlorine eradicate diseases such as E. coli, typhoid, and cholera. Though Mr. Kimaro claimed that cholera was not a problem in the municipality, ten cases of cholera were reported on November 27, 2004, only two days after he made that claim (The Arusha Times: 2004). By November 30, 2004 the number increased to sixty infected patients. The incidences were most likely attributable to unsafe water sources and it is necessary to note that fifty of them were within the municipality. (The Arusha Times: 2004). It is probable that the cases can be accredited to the lack of clean water and supplies (storage containers, pipelines, and standpipes), which forced residents to use unreliable and unsanitary sources. The Arusha Times has further speculated that overpopulation could be part of the problem as well.
The village of Olorien, located within the municipality, was chosen as the focal point of this study because not only do some residents of the village pay AUWSA for their water, but others are still using streams, wells, and rivers. The findings from this study will help to confirm whether or not unsafe water is a result of source pollution, or if household pollution contributes to the problem as well. By finding the cause of pollution and implementing necessary education for residents, the number of water-related illnesses can be reduced on local levels throughout Tanzania, and possibly the global community as well. The role of extension education in this process will be essential.

The focus of this study was to see whether or not individuals are contributing to the contamination of their drinking water supply. It is expected that many original water sources are polluted; therefore, residents need to properly boil and store their water. Simple boiling and storage procedures could greatly enhance a family’s access to safe water. Though in many areas of Tanzania residents struggle to walk miles every day to fetch water, the village chosen for this study does not experience this as a problem. Most residents have an outside spigot within fifty meters of their house, or a small river within a similar radius. To further investigate the source of contamination, residents who boil their drinking water were interviewed and their water was tested. It was hypothesized that they are not storing their water properly and thus contaminating it after it has been boiled. To support this, those with boiled water were predicted to have similar test results as those who did not boil their water. This study was conducted to assist villagers on a one-to-one basis, providing the information necessary to control the cleanliness of their own drinking water. Accessible and clean water can act as a catalyst to the alleviation of poverty, increased productivity, and a reduction in preventable diseases.

**Study Site Description:**

The location of this study was set four kilometers outside of Arusha. Arusha is a bustling city in northern Tanzania serving as a gateway to many of the National Parks and Game Reserves in Tanzania. It has a population of about 1,200,000 people (Tanzania Government Census: 2002) and is situated below Mount Meru (4565 m), a dormant volcano which last erupted in 1910 (The University of North Dakota: 2004). Arusha’s appearance is very green and lush getting an average 800mm of rainfall per year and situated in the tropical geographic zone. Villages north and east of town are fertile with water streaming directly from Mount Meru, while villages west and south tend to be more arid.

The sample population for this study is the village of Olorien located south-east of the town center, and benefiting from one main river, Kijenge River, along with a few streams. The village is home to over 13,000 residents and has 3,717 houses who frequently commute to town for work and other necessities (personal communication 2: 2004). Olorien represents diversity in economic class, family structure, as well as water collection procedures. Some households have the luxury of indoor taps, others use outdoor standpipes which only run at unpredictable hours of the day, and still others must fetch water from rivers or streams (personal observation: 2004). It is not unusual to see buckets lined up at outside standpipes or spigots, which may not be filled until well after the sun has set. With the use of high-density plastic storage tanks, residents are, at times, able to allow water to run throughout the night and collect in these tanks which they can then use the next day. Others are unable to afford this luxury. Because the village is considered urban, residents who have stand pipes
or taps are forced to pay for water. The majority of outdoor standpipes are shared by ten to twenty houses which then evenly divide the water bill. Those who obtain their water from streams or rivers do not pay for their water. A water system of three free-flowing pipes was established by the Structural Arusha Project (SAP), though the water is not free from contamination and is used by many.

Residents of Olorien are connected to Arusha Urban Water Supply & Authority (AUWSA), a private company which dominates the water supply for the municipality. AUWSA has a 42 million liter demand daily, though currently is only able to fulfill 32 million liters (IPP Media: 2004). In June 2001, they reached 14,566 clients, which was recently increased to 18,900 clients in June 2004 (IPP Media: 2004). Two hundred and thirteen kilometers of pipeline provide clean water to 95% of residents in the municipality (IPP Media: 2004). There are future plans of developing new water and sewage systems by 2009 (IPP Media: 2004). Though water seems plentiful around Arusha, many residents experience regular shortages.

Olorien is divided into six sub-villages (Mbeshere, Moivoi, R.C., Mwanama, Meiroti, and Suye). A similar number of houses in each sub-village were visited in order to get a representation of the entire village as a whole. The sub-village of Moivoi is mainly dominated by large estates which are rented by foreigners who work for the United Nations. Due to this fact, only three samples were taken from these high-income estates, and focus was directed primarily towards the low-income houses in this area.

The sample population composed of seventy-five households which boil their water and twenty-five which do not (three of these had bottled water which was tested). Though physical tests were administered for every house, several observations were made as well.

Methods:

The village of Olorien in Arumeru District is the sample population for this study. Households within the village were examined for approximately two weeks beginning on November 12, 2004. The sample size (n = 100) was limited to the number of tests and equipment available. Focus was directed towards households which boil their water (n = 72), though households which do not boil their water (n = 25) were used to make comparisons for physical property tests and observational data. Because the sub-village of Moivoi was dominated by residents who buy bottled water, only three houses of this type were used in the data collection (n = 3). An interview was given to each household to quantify collection and boiling procedures. The methodology has been broken up into three categories:

1. **Physical Property Tests** – All of which are dependent variables in the study
   - **E. coli** – E. coli attacks the walls of the intestines and can cause bloody diarrhea and abdominal cramps and if left untreated can be very serious. E. coli is a fecal-oral illness. It also provides conclusive evidence of recent fecal pollution and should not be present in drinking water (World Health Organization: 2004).

   - **Coliforms** - The presence of coliforms is a strong indication of fecal contamination. If coliforms are present there is a greater chance that pathogenic organisms such as bacteria, viruses, and parasites could be present as well. Though the levels will not be tested, the overall presence of coliforms correlates with the
probability one can have of contracting a disease from water (Washington Virtual Classroom: 2003).

- **TDS (Total Dissolved Solids)** – The levels of TDS were measured in ppm. Water that has a high concentration of TDS is usually associated with an unpleasant mineral taste. Though not all TDS are harmful and in fact some concentration is needed to sustain aquatic life, too many can cause health problems for humans. Those who drink water with high TDS concentration may experience a laxative effect. (Earth Force: 2004) No health-based guideline value for TDS has been proposed...though “the palatability of water with a TDS level of less than 600 mg/litre is generally considered to be good; drinking-water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/litre” (World Health Organization: 2004)

- **pH** – pH is used to measure the alkalinity or acidity of a sample. There is no guideline set by the World Health Organization regarding pH, though it is recommended to be lower than 8 if chlorine disinfection is used (World Health Organization: 2003).

- **Chlorine** – Chlorine levels were detected in mg/L. Chlorine effectively eliminates bacteria and provides a good defense against water borne illnesses such as typhoid, hepatitis, and cholera. “Most individuals are able to taste or smell chlorine in drinking water at concentrations well below 5 mg/litre, and some at levels as low as 0.3 mg/litre. At a residual free chlorine concentration of between 0.6 and 1.0mg/litre, there is an increasing likelihood that some consumers may object to the taste. The taste threshold for chlorine is below the health-based guideline value” (World Health Organization: 2004)

2. **Observations taken at each household include** (all of which are predicted variables in this study): The size of the container (volume), whether or not the container is covered, and approximate economic status of the household.

3. **Interview**

**Results:**

The main findings of this study include correlations between predicted variables and physical property tests. *E. coli* and coliforms are indicators of contamination brought forth by storage/handling procedures. Chlorine, pH, and TDS are indicators of original water supply quality and did not vary significantly for those who boil their water versus those who did not. Looking at Table 1, it is clear to see the averages between boiled and unboiled for these categories showed no difference. All original water sources and household tests showed up negative for Chlorine. To ensure the testing kit was accurate, a control was tested by adding a tablet of chlorine to a sample of water and it was confirmed that the test was functioning correctly. TDS and pH were never found to be above or below standard levels,
and for this reason no further data analysis was needed. They do not serve as indicators for household contamination.

Physical Property Test Results:

**Household Findings:**

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boiled</strong></td>
</tr>
<tr>
<td>Y</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Household income</th>
<th>Low (47)</th>
<th>Low Medium (20)</th>
<th>Medium (19)</th>
<th>Medium High (3) and High (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% with <em>E. coli</em></td>
<td>42.5%</td>
<td>5%</td>
<td>10.5%</td>
<td>27.3%</td>
</tr>
<tr>
<td>% Who boil their water</td>
<td>59.6%</td>
<td>85%</td>
<td>89.5%</td>
<td>90.9%</td>
</tr>
</tbody>
</table>

Chi Square Test Results

All predicted variables were compared with coliforms and *E. coli* using chi-square tests to determine whether there was a significant difference between each set.

<table>
<thead>
<tr>
<th>Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boils</strong></td>
</tr>
<tr>
<td><strong>Household Income</strong></td>
</tr>
<tr>
<td><strong>Container size</strong></td>
</tr>
<tr>
<td><strong>Source</strong></td>
</tr>
<tr>
<td><strong>When boiled</strong></td>
</tr>
<tr>
<td><strong>Who boils</strong></td>
</tr>
<tr>
<td><strong># of people in household</strong></td>
</tr>
<tr>
<td><strong>How often boiled</strong></td>
</tr>
<tr>
<td><strong>How long boiled for</strong></td>
</tr>
</tbody>
</table>

N.S. = Not significant  
* p < .01  
** .001 < p < .01  
*** p < .001  
$\chi^2$ = chi statistic  
p = probability value  
df = degrees of freedom

Chi-square tests were used to compare household income versus boiling or not boiling water. There is a significant difference between the two variables.

<table>
<thead>
<tr>
<th>Table 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Household Income VS. Boiling:</strong></td>
</tr>
</tbody>
</table>
The following graphs represent the data sets which showed a significant difference between two variables:

**Graph 1**

The Effect of Boiling in Relation to *E. coli* Contamination

**Graph 2**

Size of Container (L) vs. *E. coli* Contamination

**Graph 3**

Presence of *E. coli* in Relation to Household Income

**Graph 4**

Coliform contamination in relation to Household income

**Original Water Sources:**

22 original Water sources were tested:

<table>
<thead>
<tr>
<th>Source</th>
<th>Number</th>
<th>Coliforms</th>
<th><em>E. coli</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside spigot</td>
<td>14</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Indoor tap</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SAP pipes</td>
<td>3</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

All sources were free from the contamination of *E. coli* and coliforms. With the exception of the SAP pipes which were contaminated with coliforms. That project is not run by AUWSA.
Observational Results:

Most water collected was done so in large buckets which were uncovered until they got home. Buckets may have been rinsed on the outside and inside before water was added, but were never seen to be washed with soap, or bleached dry by the sun. Buckets were grasped onto at the edges when carrying the water home. Small children often collected water in smaller storage devices, and were seen drinking straight from them after filled. Every drinking water source was covered so this variable was removed from the data analysis.

The majority of large buckets had large open tops which were covered with a plastic lid or often times a dinner plate. Families using these storage devices would use small cups or bowls to fetch water out of them for use. On numerous occasions after interviewing a resident, they would fetch water without first washing their hands, sometimes having just been washing clothes, cooking, or cutting meat. There was one exception at a higher income house which had a bucket with a tap. There were still other houses which used small pitchers, all of which had small spouts for pouring.

Household economic status was estimated at each residence by observing size of house, type of structure, location, and personal belongings. For instance, a one-room house made of sticks and mud was placed as low, whereas a concrete house, with a tin roof, whose owner had a television and car, was placed in the high category. Also associated with household income was whether or not the household had a refrigerator, which was only the case at less than ten houses visited.

Discussion:

The predictor variable found to be most interesting in relation to dependent variables was the boiling of one’s water. Using chi-square tests it was found that boiling water had no significant effect (p>0.05) on the presence of coliforms in stored water. It is important to note that not all coliforms are harmful. They are a good indicator that organic materials are decaying which further suggests potential contamination from surface water. This can indicate that the water source is at risk (IDEXX Laboratories: 2004). More importantly, the act of boiling did show significance in relation to the presence or absence of *E. coli* (p<0.05). It was very apparent that a high proportion (80%) of those who did not boil their water had *E. coli* contamination (See Table 1 – pg 9). Whereas those who did boil their water, had only 39% of the samples contaminated with *E. coli*. Likewise, there was no significant difference in samples boiled with relation to the length of time households claimed to have boiled their water (p>0.05). Though important that water be boiled, a difference of bringing it to a boil versus rapidly boiling for twenty minutes had no significant difference in presence of coliforms or *E. coli* (p>0.05). “Simply bringing water to 65.5 degrees Celsius will suffice for safe drinking water, eliminating almost all likely pathogens” (Forgey: 1995).

The one who boils does not affect the likelihood of *E. coli* or coliform contamination (p>0.05; p>0.05 respectively). As long as water is brought to a boil, the one administering the procedure should not and proved not to affect the quality of the water.

Though it was predicted that houses which boiled water more frequently than others would have less contamination, the chi-square tests again showed there was no significant difference (p>0.05). It was also predicted that households with a larger number of people
would have higher rates of contamination due to a greater chance of children putting their hands in water and having more overall vectors, again there was no significance (p>0.05). It is possible that true numbers of household residents were not acquired due to individuals withholding real numbers. Because households were simply asked most of the questions which served as independent variables, it is possible that there was some amount of discrepancy between the answers which were given and the true values. None the less, it is apparent that storage and handling procedures added to household contamination more than actual boiling procedures.

In support of the prediction that the larger the container, the more contamination, a chi-square test displayed a significant difference in size of container versus presence of *E. coli*. The larger the container, the likelier it is that water stands around (p<0.05). This allows a greater time period for the water to become contaminated. More importantly, the majority of large containers did not have small spouts. Several houses which kept their water in large containers (i.e. 10L or greater) rather than a pitcher, would tend to use a small cup or bowl for fetching water out of the bucket. The introduction of foreign objects into a clean water source can be a main source of contamination. Simultaneously, as the object may be causing contamination, the contact of one’s hands with water also presents a source of pollution. It was observed at one home where the head of the household was cutting raw meat, that when asked to fetch a water sample, without hesitation grabbed a cup with dirty hands and dipped it into the drinking water. Similarly, small children were often seen handling the lids of containers and/or using unclean cups to get water. Such observations, though not quantified in this study, are clear, viable means of pollution. It was hypothesized that covering the drinking water supply would keep it cleaner than if it were uncovered. All houses covered their water, so this variable was removed from data analysis. Observations made on the first initial prep day at one of the original water sources exemplifies that residents are not thoroughly or properly cleaning containers before collecting their water, but instead just rinsing the outside and inside of the storage device. When carrying water home, their hands may be a source of pollution as they grasp the sides of the buckets.

Twenty-two original water sources were surveyed to get an overall idea of whether or not contamination was already present when households fetched their water. Fourteen outside stand pipes were tested, five inside taps were tested, and a recently built system of three outside pipes, free to use by all residents, was tested. All outside stand pipes and inside taps were free from coliforms and *E. coli*. The newly built system had coliforms present, though it must be noted that all but two of the houses tested acquired their water from outside standpipes and indoor taps, not from the river or newly built system. This further suggests that most contamination is likely coming from storage and handling procedures. There was no significant difference found in coliform or *E. coli* presence of those who fetch from outside stand pipes and those who fetch from indoor taps.

Critically important was the discovery of no chlorine in every sample tested. Chlorine is supposed to be added by the municipality as a purifier. As a residual, chlorine should have a lasting affect. For this reason it is important that it be pumped daily and with high enough concentration to remain throughout the pipelines and make it to the standpipes. Because AUWSA states that chlorine is their way of disinfecting the water within the municipality, it is crucially important that the concentration of added chlorine is strong enough not only to initially disinfect the water at the plant, but also to disinfect the pipeline as it travels through, and a minimal amount to make it to the household.
Using observational data, chi-square tests were used to analyze household economic status in correlation with presence of *E. coli* and coliforms. The results clearly show that there is a significant difference (p<0.05) between household income and both of the two variables, suggesting the lower the household income, the greater the chance that *E. coli* and coliforms will be present (See Table 3). After coming to this conclusion another chi-square test was used to examine the correlation between household income and how many samples were boiled vs. unboiled. There was a significant difference (p<0.05) in household income and whether or not households boiled their water (See Table 4). This perhaps gives more insight into the first chi-square test. Because it can be expensive for families to boil their water, poorer families in turn have a greater chance of acquiring *E. coli*.

**Recommendations & Limitations:**

With more time allotted, a worthwhile extension of this study would involve seeking physical property tests at numerous original water sources and then follow people as they collect their water, boil it, and store it. Water quality could be tested at the original water source, after boiling, and then again a couple days later after storage. A direct correlation between original water sources and drinking water quality would provide more insight into route and source contamination. Perhaps meeting with families more than once could provide some credibility for the researcher, which would allow for more honest answers during the interview process. As well, a study composed of a larger sample size always allows for better representation and analysis.

Though the village of Olorien was an excellent study site, the arrangement of housing made it difficult to propose a formal means of random sampling. Though many families live in separate houses or one-room abodes, they frequently share drinking water. For this reason, the exact population of houses was difficult to assess. Several of the data sets would have provided significant differences if the sample size had been larger. The amount of testing supplies available limited the sample size to one hundred houses. Observations were qualitative and specific to the researcher. For instance, household income (low, medium, or high) was a rough estimate made by the researcher at each house.

**Conclusion:**

This study clearly defines the importance of storage and handling of household drinking water. More emphasis and education needs to be directed towards proper means of such procedures. Though many residents claim to dislike the taste of boiled water or they lack the money to boil it, the chance of getting *E. coli* contamination is significantly reduced if water is boiled.

Large containers, though possibly more convenient for households, are posing problems with outside vector contamination. Furthermore, simple metal spigots can be added to such buckets to prevent the occurrence of outside source contamination.

Though much responsibility needs to be placed on residents themselves and their ability to properly maintain and store their water, the municipality also holds a community wide responsibility in source quality. It has become evident that chlorine is not being added often enough and/or not in high enough concentrations, and at best on a sporadic basis. If the correct amount remained in the water when residents collected it, perhaps it could help with
the disinfection of storage containers as well. A push needs to be implemented by local residents to force AUWSA to better assess the municipality’s water supply.

Though organizations such as the United Nations play a crucial role in the development of water supply systems, the role for extension needs to be focused towards communities directly. Perhaps with the implementation of NGO’s and other community-based partnerships, clean and safe water can be more readily available to populations lacking access. Field data needs to be collected regularly to assess the quality of water being pumped out of sources. Further research needs to be executed in an effort to clearly define the means of contamination in the household. Large organizations can focus extension on the number of citizens worldwide who have access. “On-the-ground” partnerships can extend their efforts to assure that proper implementation and availability is present in communities. Residents need to concentrate on lowering the number of routes of contamination, and practicing sanitary means of handling and storing their water. Extension education programs can assist in this process.

References: