WATER AND WEALTH: A GUATEMALAN CASE STUDY

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ABSTRACT

The world has invested billions of dollars on water supply and sanitation. A growing body of literature investigates the benefits of these investments. Significant research exists on relationships between drinking water and health; sanitation and health; drinking water and economics; and sanitation and economics. However, very little peer-reviewed, scholarly, quantitative research exists linking the four factors together: drinking water, sanitation, public health and economics. Even fewer of these studies are longitudinal. In addition to documenting the relationships, this manuscript builds a foundation upon which future studies can build an understanding of these relationships over time.

This paper investigates drinking water, sanitation and the economic situation of 160 families currently living in San Lucas Tolimán, Sololá, Guatemala. Over the past decades, the families have been able to purchase small plots of land in two small communities on the outskirts of San Lucas. The two communities are Sanik-Ya and Chitulul. Currently the families have to walk from one to four miles to reach their land. The 160 families want to move to their land in Sanik-Ya and Chitulul. The major problem facing the families is that the closest source of water is a number of miles away. Once the villagers install a drinking water system they will be able to move to their land, improving the quality of their lives substantially.

Sanik-Ya and Chitulul are working with the support of the non-governmental organization (NGO) Agua del Pueblo (AdP). AdP has built over 700 drinking water projects benefiting 20% of the rural population of Guatemala. This paper will also provide a brief history of AdP and a description of the proposed project.

At the time of this writing, the communities have installed the majority of the pipeline. Furman University in Greenville South Carolina and the People's Consultants (PC) have provided the majority of the capital costs to date. The People's Consultants is a non-profit organization founded in 1973 to help establish AdP. The Internal Revenue Service recognizes PC as a non-profit under section 501(c)(3). Donations for the project can be made through PC's web site: http://peopleswater.org/. The San Lucas Mission has also supported the project. The Rotary Clubs of Santa Cruz, California, the Peninsula Sunrise Rotary in Redwood City, California and Rotary International are also contributing to and considering supplying additional funding for the project.

The researchers collected the data through a survey of 40 randomly selected families of the160 families. The survey included qualitative and quantitative questions on current water, sanitation and economic conditions. The results of this survey show that the greater the family's wealth the more willing they are to support the water project financially, participate in conversations with others while collecting water, and use lake water. The data also demonstrated that the families living in certain parts of San Lucas were better off financially.

Key Words: Development, Water, Economy, Sanitation, Agua del Pueblo, Guatemala, Case study

INTRODUCTION

One of the United Nation's Millennium Development Goals is to halve the population without sustainable access to safe drinking water and basic sanitation by 2015 (United Nations, 2010). The goal will be challenging with 884 million people worldwide currently lacking access to safe drinking water and 2.6 billion lacking basic sanitation services. An important aspect of this goal is that it specifies sustainable access. Recent literature has demonstrated that sustainable development depends on a high level of community involvement, or more importantly, community management (Clemens, Karp, & Papadakis, 2002; Laverack, 2001; Shortall & Shucksmit, 2001; Wegelin-Schuringa 1998; Rifkin, 1990; Fox, 1992). Differences exist between the developed and developing world (Lasmin, 2011; Violet & Alexander, 2009). The difference between community involvement and community management is that community management involves the community in the decision making process. In community management, the community owns and eventually maintains the systems, leading to a stronger sense of ownership and empowerment. '… Local residents must be viewed as the key actors, the subject of their own problems and not as objects for who outside institutions must plan and do things' (Espinosa and Rivera, 1994:16). This is one of the key factors of interest in effective development and water development is the method used in this case study to create community empowerment. A similar study concluded that 'WD [water development] in its present form is a necessary but not a sufficient condition to sustain rural livelihoods. However, WD does carry the potential for enhanced livelihood security' (Reddy et al. 2004:324). Agua del Pueblo (AdP) is a non-profit, Non-Governmental Organization (NGO) founded in Guatemala with the goal of assisting rural communities to obtain improved water and sanitation systems. Arguably AdP's greatest success is its efforts to empower local communities. AdP's methodology ensures that communities develop themselves, assist other communities in development projects, and successfully maintain their own systems (Evans & Appleton, 1993). The director of AdP emphasizes that the goal of AdP is not merely water or sanitation, but to use these projects as a means to address poverty and underdevelopment (P. Quijivix, personal communication, May 25, 2011).

AdP and similar organizations have developed not only Guatemala, but throughout the developing world in order to combat poverty. Kay 1991 explains how the globalization of capitalism has almost forced these types of groups and disparities, even within countries. He goes on to explain the Centre-Periphery economic theory which argues that capitalist growth in the centre (developed countries) allows for growth and development, but simultaneously puts pressures on the periphery (developing countries) which prevent the areas from benefitting from market and technological advances as easily. The three main reasons to which he points are: surpluses in labour, a lack of unionization, and higher export competition when compared to the developed nations (Kay, 1991). A simple example of this problem was the highly variable price in coffee, a major cash crop grown by many in Guatemala. The varying price made living

difficult for many locals, before a supporter of AdP, the late Father Greg Schaffer offered a program where the nearby parish would offer a constant price for coffee. The parish would use any profits from unexpectedly high prices to offset losses from unexpectedly low ones. This program is simple by design, but the ability of farmers to know what their crops would earn them in advance was an invaluable tool which allowed them to apportion their spending accordingly. As such, this program greatly helped improve coffee farmers earnings and allowed them to improve their daily lives over time. This type of solution; simple, but effective and meaningful is exactly what AdP works for and incorporates into towns to allow for growth to spur further growth.

Agua del Pueblo's History

A number of foreign and Guatemalan volunteers formed Agua del Pueblo, 'the People's Water,' in 1972 in San Lucas, Tolimán to help three local villages obtain potable water. Agua del Pueblo (AdP) follows a specific methodology while helping a community to ensure maximum impact. First, AdP only responds to 'felt needs'. That is, AdP does not solicit communities for projects. Communities must approach AdP directly. This method ensures that the community is already organized and that a communal demand exists for an improved water system. Reddy (1999) showed evidence that this improves the likelihood of successful collective action. When comparing two similar villages, the economically poorer and more water scarce village was more effective in community action for societal benefit. She declared that, 'these apparent disadvantages seem to be reasons behind, if not necessarily conditions for, the success of collective action' (Reddy 1999:90). Soon after a community contacts AdP, AdP 'barefoot engineers' perform a one-day, preliminary engineering and socio-economic study. AdP discusses the results of this preliminary study with the entire community. The preliminary study includes a number of options as well as preliminary cost estimates. AdP's preliminary cost estimates have consistently been within 10 per cent of final costs. The AdP methodology requires that the community form a 'water committee' to represent and organize the community. The community itself is responsible for a portion of the financial costs of the project, and all of the labour of the project.

In order to facilitate their work, AdP also trains Technicos de Acueductos Rurales (TARs). A TAR is a 'Rural Water Technician;' local residents trained in the supervision, management, planning, design, and construction of rural potable water systems (Clemens et al, 2002).

AdP ensures that the entire community receives adequate training and is fully informed of all expectations such as the cost that they will burden and labour that may be needed (Evans, & Appleton, 1993; Clemens et al, 2002). By involving the community in the decision making process and requiring some financial input, AdP gives the community a full sense of ownership and itself provides merely a supporting role. As Arlosoroff (1987: 37) argued,

> *While many communities may need financial help, relegation of their role to that of recipients without significant participation has often resulted in an inappropriate choice of technology and service level, wrong location of the water point, unnecessarily high cost, inability to keep the scheme operating, and ultimately user rejection.*

Finally, the training ensures that the community will be knowledgeable enough to reap the full benefits of their system and to maintain the system themselves without the need of

significant outside intervention. This method focuses on keeping the communities in control of their projects, which Lockwood (2004) explains will ensure that communities are invested in the project and will work to ensure that it and its benefits are lasting.

Recent literature provides evidence of the benefits of community empowerment for sustainable development and progress. Espinosa and Rivera (1994:14, 28), argue that 'this kind of model and methodology are not only viable but also more successful than traditional models' and that 'active community participation in developing and implementing solutions can lead to a sense of ownership by the community that greatly increases the sustainability of a given activity or enterprise.' Subsequent researchers support and extend the argument (Campos and Zapata, 2013 and Owusu, 2013). Swaminathan (1995) demonstrated that public action involving the community with an organized group such as AdP is *necessary* to help raise standards of living.

Espinosa and Rivera (1994) found that the residents in Guatemala City were able to adapt a health and sanitation program to bring about other benefits such as literacy improvements, preschools, and even a leadership-training program. Campos and Zapata (2013) add that community focused programs often expand into neighbouring locations. Clemens, Karp and Papadakis (2002) described how AdP projects provided such ancillary benefits (Clemens et al, 2002). Fox (1992) found similar results in Mexico in which a small government branch supported local farmers to band together in order to improve their agricultural success. This group further advanced into its own network, 'Lázaro Cárdenas Ejido Union' (UELC) (Lázaro Cárdenas communal farmer Union). The UELC now includes not only farming support, but owns its own fertilizer production facilities and sponsors house development/improvement projects as well. This ULEC even supported the development of another similar, but larger network, the National Union of Autonomous Regional Peasant Organizations (UNORCA).

In AdP's first 30 years, the non-profit organization trained more than 700 public health workers, constructed over 21,000 latrines, and benefited over 100,000 residents (Clemens et al, 2002). AdP's efforts in Guatemala have helped the country enjoy considerably higher rural water supply coverage than countries in similar situations in Latin America. In some Guatemala states, 92 per cent of the residents have access to sustainable drinking water. Some more economically developed countries such as Brazil are as low as 58 per cent (Solanes and Jouravlev, 2006). The rural poor are especially in need of support such as this as they often lack their own voice to work towards development. Having AdP give them the chance to ask for developmental assistance and have them develop their own representatives to support self-development is crucial to the success of the long-term development after the initial project's end (Fox, 1992).

Recent interviews confirmed that local residents recognize the benefits of the AdP methodology. One key is the transparency of non-profits (Elson, O'Callaghan, Walker, 2007; Smith & Richmond, 2007). Resident Felipa Umul Cotuc explained that, 'the community was isolated, but now we are starting to band together. Other committees have attempted and failed projects such as this, but they were formed for their own benefit… This committee does it for the community.' (Personal communication with lead author during interviews, May 2013).

AdP foreign and local staff has supported the rural poor in Guatemala. Kay (1991) provides a theoretical explanation. The author suggests that having one dominant mode of production "leads to the subordination and exploitation of certain economic and social sectors, of certain segments of the population from certain geographical regions, by others" (Kay, 1991:40). This explains why rural Guatemala is in much more need than urbanized Guatemalan areas such as Guatemala City or Antigua. Kay also states that this type of "internal colonialism" is separate

from rural-urban relations and class relations as it is based in discrimination, which cuts across class lines. Guatemala has a turbulent history of this discrimination of the indigenous, a 36 yearlong civil war between the government and primarily rural indigenous. AdP and AdP sponsored committees were at significant risk. The Guatemalan federal government considered rural individuals supporting community empowerment possible rebels. Regretfully, AdP training increased local risk. Due to the economic inequality and the process of "internal colonialism" AdP has focused on supporting the 'poorest of the poor'.

Des Gasper (1996) suggested that culture is an integral part of development and must be considered. Gasper discusses that there are multiple ways to view culture, which can drastically change the outcome of development attempts (Gasper 1996). AdP is not prone to bias towards imposing western beliefs on other societies as AdP has become fully run by Guatemalans themselves.

Specifics of the Case Study

The Sanik-Ya and Chitulul project is a good choice for this case study for a number of reasons. Currently, only one family lives full-time in Sanik-Ya and Chitulul. The people who own property in these areas are living in the neighbouring city of San Lucas Tolimán. San Lucas Tolimán (population 30,956) is the municipality to which Sanik-Ya and Chitulul belong (Instituto Nacional de Estatística, 2013).

The large majority of these people would rather live in their properties in Chitulul and Sanik-Ya, but are unable to do so because there is not currently any water system available. Moving to their larger properties in Sanik-Ya and Chitulul will significantly improve the lives of these families. They own their own land in Sanik-Ya and Chitulul, but many now rent in San Lucas. Families would be able to work their fields more effectively, which is vitally important in an agrarian society such as this. Families also explained during the interviews that their small city-size living areas force them to live in small, cramped homes with as many as eight family members in a home meant for two. The interviews will be discussed in more detail later in the methods section.

Although San Lucas does have a municipal water system, the system does not deliver potable water throughout the day to all residents. The interviewers asked several questions pertaining to the current situation with water. The large majority of the respondents had significant problems with the adequacy of their current water source. The existing water system pumps water from Lake Atitlán, which San Lucas borders, into two tanks before distributing it. Unfortunately, the lake is heavily polluted. Residents will often bathe in the lake and wash clothes using chemical detergents. Another concern is that the rainwater washes all waste from San Lucas into the lake.

Lake Atitlán's situation has deteriorated to a point so low that the Global Nature Fund named it the threatened lake of the year in 2009 (Global Nature Fund, 2013). Many towns border this 130 square kilometre lake and as many as 74 per cent of the people living in these areas are living in poverty. The lake suffers from litter and chemical contaminants and began to show the extent of this contamination in 2008 with a large algal bloom. This bloom covered 75 per cent of the lake at one point. An inlet such as the one that San Lucas Tolimán uses is more affected by the higher concentration and lower flow of the area (Global Nature Fund, 2013).

The municipal system only chlorinates the water; it does not remove all of the pathogens from the water. Interviewees shared numerous complaints about the water system. The

chlorinator on the municipal system tends to cause problems. Some residents complained about contamination and a lack of chlorination in their water. Other residents complained about over chlorination causing skin and stomach irritation. One of the families explained that their water sometimes arrives so highly chlorinated that the vapours generated from boiling were noxious. Other complaints included contamination such as trash or chemical contamination. One interviewee explained that the water would come in so contaminated that it was yellow after large rains. Due to these reasons and more, most residents do not believe that their current source is healthy to drink. Most will either boil it before drinking it or buy bottled water. The Municipality charges 10 Quetzals monthly (approximately $1.30US) for municipal water. With some families making fewer than 200 Quetzals a month, even the monthly payment can be difficult to manage. Bottled water is far too expensive for many Sanik-Ya and Chitulul project participants.

The municipal system does not function adequately for many residents. Some families explained that they have been forced to go as many as 15 days without access to water. During which times they must either buy bottled water for all uses or resort to walking to the lake for their water. Other interviewees mentioned that they only have access after dark until sunrise. This leads to further problems with health. Those without water will go directly to the lake and thus be using completely untreated, polluted water. Another concern according to Tonglet, Isu, Mpese, Dramaix, and Hennart (1992) is that a distance greater than a five-minute walk can lead to less water being used and increased illness. This applies to the majority of San Lucas as people live between approximately five to 20 minutes away from the lake.

Figure 1 illustrates the boundaries of San Lucas Tolimán as well as Chitulul and Sanik-Ya. This figure also provides the location of the intended water system and the current tank, which will serve as the source for Sanik-Ya and Chitulul.

Figure 1: San Lucas, Sanik-Ya, and Chitulul

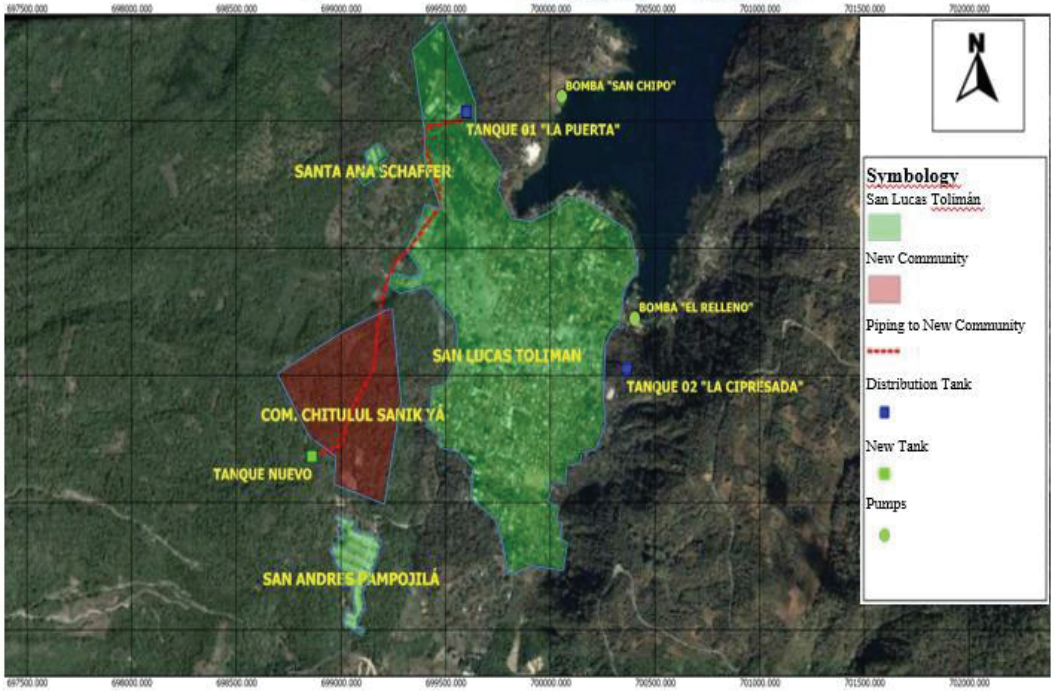

Figure 1 depicts an image of San Lucas, Tolimán with boundary lines for the city and for the planned towns of Sanik-Ya and Chitulul. It also shows a dotted line from the current tank to the planned area of the second tank. Map provided by Francisco Javier Juarez Santizo. The Spanish is translated as below:
1. Bomba "San Chipo" = Secondary San Lucas Municipal pump (San Chipo).
2. Tanque 01 "La Puerta" = Existing municipal tank ("The Door") from which the project will pump.
3. Santa Ana Schaffer = Adjacent community named for Monsignor Gregory Schaffer (RIP).
4. Bomba "El Relleno" = The original still-functioning San Lucas municipal pump.
5. Tanque 02 "La Cispresada" = The original distribution tank for the municipality of San Lucas.
6. Tanque Nuevo = The new tank designed for the Sanik-Ya and Chitulul communities.
7. San Andres Pampojilá = Adjacent town named for the Pampojilá plantation

THE CASE STUDY: THE SANIK-YA AND CHITULUL WATER PROJECT

Ordinarily, AdP helps supply water to existing villages without adequate access to water. In this situation, AdP is providing water to a new area to allow people to begin moving there. According to Victor Racancój, the Chairperson of AdP's Board of Directors, this is likely to become more common as over-crowding in cities is becoming a larger problem (personal communication May 2013). The Sanik-Ya and Chitulul system will use municipal water that is pumped to one of the two distribution tanks. The north tank that the project will use draws water from the cleaner area of Lake Atitlán. The project will install a booster pump at the north tank and connect it to another tank. The new tank will be placed at the highest point of the two communities, near San Andres Pampojilá. From this new tank, the water can flow by gravity to Sanik-Ya and Chitulul.

Unfortunately, this system is more costly per capita than a typical AdP project. Water must be pumped more than four kilometres to a height of more than 90 meters above the existing tank (Simon, 2013).

The new system will provide a significantly more consistent supply. Just this increased consistency can be quite beneficial. According to Esrey, Feachem, and Hughes (1985) increased quantity of water can have a greater impact than water quality improvements. The plan is to install an additional chlorination system to improve the quality of the water as well. This improvement in water could dramatically change the lives of those in San Lucas as the World Bank feels that unsafe water causes about 88 per cent of disease in the developing world (Fogden & Wood, 2009). An often-overlooked concern of illness is not the direct cost of health care, but the indirect cost of lost school or workdays adding a further economic burden (Fogden & Wood, 2009).The total estimated cost solely for water project materials is $100,000. Agua del Pueblo will design and oversee the construction. US university students have collected over $29,000 dollars including a grant from the Duke Endowment. Fundraising for the project is still underway.

The potential beneficiaries are already hard at work. Sanik-Ya and Chitulul have established a Concejo Comunitario de Desarrollo (COCODE) (Community Development Council). The Council has rallied the people towards building a large, improved road connecting Sanik-Ya and Chitulul to San Lucas. The road will not only make the process of building the tank much simpler, but it is also helping the community feel united, see real progress in their work, and improve the situation for many who currently use the road for their profession or to collect firewood. The community is building the road in a sustainable manner. The road is designed to withstand the rainy season by placing a spillways of basalt and granite rock in the road every 10 meters. This stone line is a simple way to minimize erosion. The future residents of Chitulul and Sanik Ya are building the road by hand with solely volunteer labour on Sundays.

Francisco Juarez, the first Vocal of the COCODE and Carlos Simon, AdP's lead engineer, estimate that, once the funds are available, the entire project could likely be finished within three months (F. Juarez and C. Simon, Personal communication, May 10, 2013). An interesting story worth noting is that although Francisco Juarez is the first Vocal, the highest non-officer rank in the COCODE, Mr Juarez does not own nor intend to purchase land in Sanik- Ya or Chitulul. He is helping with the project significantly and doing so only out of his good spirit.

METHODS

Measures

Wealth: The researchers measured the level of wealth using the mean of the weekly wage, monthly wage and a coded value for the profession of the main family breadwinner (Cronbach's alpha of 0.83). The researchers uncovered four categories of professions: Jornaleros, Agriculturalists, Artisans, and Salesmen. Jornalero refers to a generic day labourer without a specific profession. Artisans included professions such as shoemakers, masons, bakers, etc. Salesmen included accountants. The researchers assembled an expert panel from Guatemala to rank the wealth of the four professions. The researchers coded the four categories of profession from one to four from least wealth to most wealth. This value was then averaged with coded values for both the wage made within the past week, and the wage made within an average month for the families interviewed to obtain the measure for wealth.

Location: Before the interviews were conducted, the COCODE separated the families into four separate teams based on their location. The COCODE assigned the teams so that the interviewers would be able to more effectively interview all 40 families. As each team interviewed a different area, the researchers used the team, which interviewed the family to measure location.

Willingness to Support the Project: The researchers and AdP were interested how willing the community was to financially support the project. The researchers measured willingness to support the project in three ways: the family's willingness to support the project in order to obtain a cleaner source of water, to obtain a closer source of water, and to obtain water within 30 feet of their home. The researchers kept these three questions separate.

Problems obtaining water: This was an open-ended question asked to residents and explained by the members of the COCODE who assisted with the interviews. Instead of coding this question based on the problems explained such as inconsistency of the system, contamination, over chlorination, the researchers felt that coding it on a simple yes or no basis should suffice to show correlations between this and other parameters.

Number of people in the house age 15 or younger: This was a question to understand how large average families in the area may be and to understand how more children in a household may affect sanitation, water, or economic situations. Any child under 15 who lived in the home was included as many homes contained more than one family.

Use of rainwater: The interviewers asked if the residents made use of rainwater to any extent. If they answered yes, they were asked a rough approximation of how much they depended on this source. As Guatemala has a seasonal climate with heavy rains during half of the year, and a dry period for the other half it is not possible for one to survive with solely rainwater.

Use of lake water: The interviewers asked families if they made use of any sources of water other than their main source. The main source for all families was the municipal source. The only responses garnered from this question were use of rainwater and direct use of the lake water.

Survey Development and Use

The authors designed the survey based on a previous study of water and economic development (Elmendorf and Buckles, 1980). Survey interviews have the advantage of obtaining contextual data (Brears. 2012). The research team translated the survey into Spanish. Women typically have the largest vested interest in improving the water and sanitation (Elmendorf and Buckles 1980; and WHO/UNICEF 2010). In fact, the one family, which has moved to their property, told the researchers how the man of the house was unsure of the move until his wife pushed the decision and convinced the family to move. In general, women are the most impacted by water related tasks. Thus the researchers had to obtain the majority of the data from women. The first language of the majority of the population is Kaqchikel, the local Mayan language. Typically the older women did not speak Spanish.

Members of the COCODE translated the Spanish survey into Kaqchikel. The research team randomly selected 40 of the 160 families who own property in Sanik-Ya and Chitulul. The research team of ten students, two faculty members and a guest conducted all of the interviews. The COCODE divided the 40 families into four geographic groups to minimize travel time. The lead researcher assigned four research teams, one to each of the four groups.

The process began with students reading a Spanish Institutional Review Board (IRB) approved consent form. The interviewers read the survey questions in Spanish, and the COCODE representatives translated into Kaqchikel. The researchers gave the residents time to respond fully before the committee member would translate the Kaqchikel response into Spanish for the interviewers. The research team recorded all interviews to ensure accurate translations.

The research team contacted Francisco Juarez of the COCODE before the field visit to help prepare the communities for the interviews. Thanks to the COCODE, the residents were fully prepared. In fact, most of the villagers were looking forward to the opportunity to assist the researchers. After selecting the 40 families to interview, the researchers were surprised that families who were not chosen were actually disappointed and wished to talk to the researchers to discuss their situation. The COCODE collected additional detailed information on the professional and family situation of all of the 160 families to supplement the information collected through the survey.

The researchers input the raw data written in the surveys into an excel spread sheet. Subsequently the researchers reviewed the recordings to ensure accuracy. The researchers then entered the data into a coded system so that it could be run through the Statistical Package for the Social Sciences (SPSS) program. The researchers confirmed normality and established that heteroscedasticity was not a concern. Data were also input into an online geographic information system (GIS), ArcGIS developed by Esri, to determine if there were any variables, which were related to location.

RESULTS

Table 1 identifies the significant correlations between the variables. The most significant correlations were the relationships between location, wealth and water.

Table 1
Descriptive Statistics and Pearson's Correlation Coefficients

	Mean	Std. deviation	Number of responses	1	2	3	4	5	6	7	8
1. Willingness to pay for better water	2.37	1.03	38								
2. Location	2.79	1.15	39	-0.56***							
3. Willingness to pay for closer water	2.61	1.41	38	0.54***	-0.70***						
4. Willingness to pay for water within 30 ft.	3.29	1.11	17	0.34	-0.66**	0.64**					
5. Wealth	4.43	3.14	39	0.00	-0.42*	0.20	0.54*				
6. Problems obtaining water	1.16	0.37	38	0.24	-0.10	0.28	0.16	-0.06			
7. Members of household15 years old or younger	1.30	0.72	27	0.04	-0.29	0.38*	-0.05	-0.01	0.68***		
8. Use of rain water	2.05	1.26	39	0.4*	-0.27	0.13	0.38	0.02	0.11	-0.03	
9. Use of lake water	1.48	0.51	25	-0.40	0.45*	-0.24	0.59	-0.05	0.03	0.06	0.22

*Correlation is significant at the .05 level (two-tailed)
**Correlation is significant at the .01 level (two-tailed)
***Correlation is significant at the .001 level (two-tailed)

Researchers found one statistically significant correlation between the resident's willingness to pay to improve their water situation and their location. This applies to both a resident's willingness to pay for better quality water and closer water. What this is likely showing is that those who live further from the lake are more in need of and thus more willing to pay for improved water systems. Unsurprisingly, the data also show that those who were more willing to pay for better quality water were also more willing to pay for closer water.

Figure 2 is an ArcGIS image, which shows the willingness of each family to financially support the project. Each symbol's size is based on the willingness of the family to financially support the project. Figure 2 overlays this data on a satellite image of San Lucas Tolimán. The figure uses four different symbols for the four different interview teams.

Figure 2 San Lucas Data from ArcGIS online by ESRI

Figure 2 is a map of San Lucas with embedded figures created using ArcGIS. Each of the different symbols corresponds to a different interview group and the size of the symbol corresponds to the willingness of the family to pay for improved facilities. The larger symbols represent families who are more willing to pay.

Another significant correlation is the relationship between the number of children in the family and whether the family has had problems obtaining water. It was found that the more children in the household the less likely it was for the family to report problems obtaining water. This is likely because water collection largely falls on children and women in many areas. Thus more children provide more people getting the water (Elmendorf and Buckles, 1980).

It is probable that this is also why the number of children is correlated to the willingness of the family to pay for water on their property. This would be a way to free up time for the children and women of the home.

The data showed additional correlations between the location and the use of lake water as well as location and wealth. The data points to the idea that there are areas in the community, which are wealthier on average. It would seem that those further on the outskirts of the town were those who were less wealthy. This is not an uncommon finding with other papers in both developed and developing countries showing that wealth is tied to location (De Oliver, 1999; Venables, 2005).

As the centre of cities is commonly the area with most opportunity in terms of employment, living on the outskirts would be less desirable and more difficult, especially in a town so close to the mountainside were the outskirts are at risk for landslides.

The evidence also shows that those who are further from the lake reported a higher use of the lake water directly. This may seem counterintuitive, however since they live further from the lake they are also towards the edge of the municipal water system. As they live further from the lake, this means that they must walk even further to reach their water and are thus left with less time, another factor likely leading to the lower wages in these areas. Although the health information is still being collected, the researchers foresee a similar correlation between location and health (Arrossi, 1996; Esrey, Feachem & Hughes, 1985; Clemens and Douglas, 2012).

The results show a negative correlation between the use of rainwater and the willingness to pay for better water. The idea that those who use rain water are less willing to pay for better quality water would seem to point to the fact that those collecting rain water had already found a way to access fairly clean water and are thus in less need of it.

Finally the willingness to pay for water was significantly correlated to wealth. Those who were better off financially were more willing to pay for water on their property. This supports the results of Reddy (1999), which found that willingness to pay was positively associated with farm size, which can be considered another measure of wealth. Other work from the study by Reddy (1999) showed that some areas had such poor water pressure that they had inconsistent water supplies. This was shown to negatively affect their desire to pay for water in their homes, and actually showed indifference between household connections and stand posts. Water supply for many in San Lucas, especially those with less wealth, was incredibly variable as well with as long as two weeks without water reported. This could be an underlying cause for the correlation between willingness to pay and wealth as the rich having better views on water delivery systems than the poor, causing them to be more willing to pay.

The results of the survey will serve as the baseline of a longitudinal study of the area to obtain quantitative data explaining the benefits of improved water development and community empowerment. Numerous articles discuss the links between water, economics, sanitation, and health, but there are very few which are longitudinal and virtually none, which examine all parameters simultaneously. In previous research it was found that there was 'a direct positive relationship between investments in integrated projects in potable water supply and improved sanitation and economic development' as well as a positive relationship between public health and economic development (Clemens, and Douglas, 2012). It is hoped that this longitudinal study verifies and builds upon these findings, but as this is the initial data, only relative correlations between multiple parameters could be found at the time.

LIMITATIONS OF THE STUDY

One significant limitation was the sample size. Due to time and budgetary constraints, the researchers limited the sample to 40 families. Furthermore the data were all obtained from a single town in a single country. While residents of other areas may be in similar conditions, regionally dependent variables such as climate, geological conditions, etc. may play a significant factor (Nurmi and Uksvarav, 1996; Ward et al, 1999; Clemens, and Douglas, 2012).

Another limitation of the study is the language barriers between the interviewers and the native residents of San Lucas. The research team who performed the interviews did not speak the local Mayan dialect. Miscommunication could have occurred when the committee members translated between Spanish and Kaqchikel. In order to address this concern, the researchers recorded all interviews. The recordings are available from the lead author.

One unexpected limitation surfaced while reviewing the recordings. After reviewing the recordings it appears that some of the questions in the survey and some of the local translators seemed to have lead certain interviewees. Any case where it seemed like the translator may have led the question was thoroughly examined to be sure that the resident decided the answer himself.

The final limitation of this study is the reliance on self-reported information from the residents in an interview process. Much of the information desired was too personal and individual to be obtained in any manner other than a survey. Even occupation can be difficult to find in areas such as this without surveys as many men were 'jornaleros,' men who perform odd

jobs as their main source of income.

FUTURE RESEARCH

The data collected included economic, water, and sanitation information. Researchers from a medical school of a separate University are in the process of interviewing the same 40 residents to collect public health information. This paper presents only the beginnings of a longer-term research project. One short-term goal is to incorporate the health information into the current body of information. This research will also be used as the baseline data for a longitudinal study of the area. Such a study will provide valuable information on the long-term benefits of a water and sanitation project using community empowerment methods in terms of economics and health.

The authors and the COCODE of Sanik-Ya and Chitulul are committed to work with any and all researchers to continue this study. As discussed earlier, while the literature on water heath and economics has been growing, the authors were unable to find one longitudinal peer-reviewed study comparing water, sanitation, economics and health. The authors welcome additional research on this topic. The authors encourage future researchers to obtain the raw data from this research.

CONCLUSION

One purpose of this article is to serve as a basis for a longitudinal study to assess improvements, which are made during and after a water project using community empowerment methods. This article also provides correlations found within the initial data. Analysis of the interview data showed several parameters were related to specific areas of San Lucas Tolimán. Research also showed correlations between a family's willingness to pay to improve their water situation and their economic situation, use of rainwater, and number of children.

Subsequent research and the continuation of the longitudinal study will help to illuminate the complex nature of these parameters. Researchers will be able to further unravel the relationships between NGOs and rural communities. Others will be able to investigate how the interrelationships between many of these parameters can change, strengthen, or weaken over time. It is hoped that both NGOs and philanthropists will be able to use these results to help ensure that their work is even more effective.

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APPENDICES

Survey Used to Collect Information in Guatemala

1. Do you have water in your house right now? _____
2. Why do you not live in your property in Sanik-Ya or Chitulul?

   _____
3. A) Where do you obtain the largest part of your water during the year?

   _____

   B) Do you frequently use other sources during the year?

   _____
4. Do you use the rain for your water?

   _____
5. Do you reuse your water (for example, using the water from cleaning dishes for plants)?

   _____
6. Do you have problems obtaining water from these sources?
   Yes ( ) No ( )
   (If the response is yes, ask for which source and what the problem is)

   _____
7. Do you believe that the water that you drink is healthy for you and your family?
   Yes ( ) No ( )
   Why?

   _____
8. Do you believe that the time and work that you take to get the water is:
   Excessive ( ) Normal ( ) Little ( ) If the response is "Excessive," ask: if you were able to spend less time to obtain water, in what activity would you use this new free time?

_____

a. How much do you pay for your water? _____
b. Is the cost of water: High ( ) Normal ( ) Low ( )
c. How much do you and your family earn in a month? _____
d. And in the last week? _____

9. A) Would you be willing to pay more money to obtain better quality water to drink and other uses? No ( ) Yes ( )
If the response is No, ask why?

_____

If the response is Yes, ask: Little more ( ) Much more ( )
B) Would you be willing to pay more money to obtain a closer source of water for drinking and other uses? No ( ) Yes ( )
If the response is No, ask why?

_____

If the response is Yes, ask: Little more ( ) Much more ( )
C) Would you be willing to pay more money to have water within a distance ofthirty feet from our home? No ( ) Yes ( )
If the response is No, ask why?

_____

If the response is Yes, ask: Little more ( ) Much more ( )

10. Only for those who carry their water
a. Do you talk with other people in your community while getting water?
Yes ( ) Sometimes ( ) No ( )
b. Do you believe that this is good? Yes ( ) No ( ) Why?

_____

11. Do you have an idea of what could be done to help you and the community get a better quality of water?

_____

12. Why do you believe that this has not been done already?

_____

13. What system do you use for the elimination of your necessities?
( ) Latrine ( ) Vault with collection
( ) Bucket night soil collection ( ) Leave it on the ground
( ) Leave it for the animals ( ) Septic tank
( ) Other (specify) _____

14. Can you provide another time that you have worked with others on a project?

_____

15. Do you believe that you can work with other people to improve the system of water and waste disposal?
Yes ( ) Maybe ( ) No ( )
If the response is Yes, or Maybe, ask: With what group or organization would you be able to work with?

_____

In what conditions?
Voluntary work ( ) Work with pay ( ) Exchange work ( )

16. How old are you? _____

17. Profession of the head of the house _____

18. Number of people in the family that are over 15 years old (including the interviewee) _____

19. Number of people in the family that are 15 years or under _____

20. Would you like to add anything to the interview?

_____

Thank you very much for your participation in this interview. I hope to be able to help you in the fight for potable water.