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An Evaluation of a Water, Sanitation, and Hygiene Program in Rural Communities Outside of Port-au-Prince, Haiti

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AN EVALUATION OF A WATER, SANITATION, AND HYGIENE PROGRAM IN RURAL COMMUNITIES OUTSIDE PORT-AU-PRINCE, HAITI

by

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ABSTRACT

Background: In 2010, a massive earthquake left the capitol Port-au-Prince in ruins and destroyed infrastructure providing electricity, piped clean water, and waste removal to the region. Water, sanitation, and hygiene intervention programs attempt to reduce the burden of water-related disease in earthquake-affected regions. However, there are few evaluations of these programs, especially following natural disasters.
Methods: Data provided by Samaritan's Purse Canada's WASH program were examined. The data set included a household (N=1198) and a latrine (N=167) survey that recorded household use of laundry pads, bath houses, hand-pumped drilled wells, health and hygiene education sessions, and latrines as well as demographic data. Data analysis was conducted in IBM SPSS Version 20.0. Descriptive statistics were computed, and statistical relationships were analyzed for 1.) Health and hygiene education session attendance and program outcomes and 2.) Household diarrheal disease and program interventions
Results: This study found that households attending any of four health and hygiene sessions were significantly more likely to use program-provided bath houses and hand-pumped wells ($p<0.05$). Attendance was also significantly associated with increased knowledge of diarrheal disease prevention and hand washing technique. Households using the program-provided hand pump reported lower rates of diarrhea in children under five years old.
Discussion: This study concluded that health and hygiene session attendance is positively associated with the utilization of program interventions. However, further improvements in data collection methodology are needed to fully understand the effects of this multi-intervention WASH program on target communities.

Keywords: Water, Sanitation, Hygiene, Haiti, Earthquake, Disaster, Program Evaluation

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CHAPTER I – INTRODUCTION

In an increasingly dynamic global landscape, the means for achieving worldwide health becomes significantly more complex. The effects of constant civil war, devastating poverty, extreme natural disasters, and unabated population growth restrain public health efforts. Even clean water and safe sanitation, some of the most basic human needs, are out of reach for millions of people. The earliest evidence of a sanitation program dates back to 3000 B.C. The Harappan civilization, nestled in the ancient Indus River Valley, created a maze of covered stone channels to carry away solid and liquid waste. Centuries later the Ancient Romans engineered elaborate aqueducts, which transported what was considered clean spring water to towns and cities miles away (Sanna-Leena Rautanen, Luonsi, Nygård, Vuorinen, & Rajala, 2010). Traveling in time to the present, disease arising from unsafe water, sanitation, and hygiene practices claims the lives of 1.8 million people each year ("WHO | Burden of disease and cost-effectiveness estimates," n.d.).

In 2000, the United Nations created a global action plan consisting of eight Millennium Development Goals (MDGs) that address worldwide issues such as poverty, disease, food security, and human rights. Under the scope of environmental sustainability, the United Nations set a goal to halve the number of people without access to improved sanitation and improved drinking water sources by the year 2015 ("United Nations Millennium Development Goals,"

n.d.). Improved sanitation describes methods such as public sewerage systems, septic tanks, and pit latrines that safely remove excreta from potential human contact. Improved water describes sources that are protected from environmental contamination such as a protected spring or protected well ("WHO | Health through safe drinking water and basic sanitation," n.d.). By 2010, the United Nations met their MDG target for drinking water, providing 2 billion people, mostly in India and China, with safe water sources. Despite this accomplishment, there are many countries showing little or no improvement in access to safe drinking water, and current rates of improvement suggest the United Nation's sanitation goal will not be achieved by 2015. Approximately 780 million people, 11% of the world's population, remain without safe drinking water, and over 2 billion or 37% of the world's population remain without safe sanitation methods. Haiti is one of the only countries in the Western hemisphere not on track to achieve the water and sanitation MDG's on a national level. In fact, the proportion of the population without safe sanitation has actually increased by 3% since 1995 ("WHO | Progress on drinking water and sanitation," n.d.).

The many reasons for Haiti's struggle with water and sanitation are difficult to encompass within one public health program. A long history of political turmoil, beginning with the slave revolt that founded the Republic of Haiti in 1804, paved the way for governmental instability and the migration of millions of wealthy Haitians from their native country (Dubois, 2012). The poorest nation in the Western hemisphere, Haiti also suffers from extreme income disparities, with administrative regions or departments such as *Département de l'Ouest* and *Artibonite* bearing the greatest burden (Jadotte, 2007). Approximately 60 percent of all Haitians, mostly those living in rural departments, lack access to basic medical services, and Haitian children under five have one of the world's highest mortality rates, trailing just behind

Democratic Republic of the Congo, Chad, and Sierra Leone. Diarrhea, malaria, and respiratory infections are just of few the diseases contributing to Haiti's childhood mortality rate ("UNICEF - At a glance," n.d.; "UNICEF - The State of the World's Children - The State of the World's Children reports," n.d.). Considering its numerous public health problems, Haiti was ill prepared to deal with one of the most devastating natural disasters in recent history. In 2010, a 7.0-magnitude earthquake left the capitol Port-au-Prince in ruins and destroyed the already weak infrastructure providing electricity, piped clean water, and waste removal to the city and its surrounding areas. In the aftermath of the earthquake, close to 1.5 million Haitians were left homeless, without food, water, or even basic sanitation (Harrington, Gorgone, & Jocelyn, 2012).

The Purpose of this Study

In 2012, Samaritan's Purse (SP) implemented a water, sanitation, and hygiene (WASH) intervention program outside Port-au-Prince, Haiti to address water-related disease in communities impacted by the 2010 earthquake. They subsequently collected diverse evaluation data of this program. The purpose of this evaluation study was to examine and describe potential strengths, weaknesses, and opportunities within the intervention program as well provide recommendations for future WASH projects in Haiti and in other developing countries. Specifically, the evaluation focused on identifying areas of improvement concerning the consistency and reliability of the field data collection process. Data concerning household demographics, household diarrhea prevalence, laundry pads, bath houses, hand-pumped wells, and pit latrines were collected within two separate surveys. Analyses included examination of the efficacy of the various components of the intervention program described in detail below as well as their effect on reported health behaviors and the prevalence of diarrheal disease in selected Haitian communities. The evaluation answered the following research questions: 1. Are the

program goals of increasing access to potable water, improving sanitation, and improving hygiene behaviors being addressed by current data collection practices? 2. How can Samaritan's Purse improve their data collection process to further address these goals? 3. How are program inputs such as hand pump installation and hygiene education sessions impacting program outcomes?

CHAPTER II - REVIEW OF THE LITERATURE

The term "water-related disease" describes a variety of ailments, encompassing parasitic, bacterial, viral, chemical, and nutritional disorders. Many water-related diseases are transmitted through ingestion of food or water contaminated with human or animal fecal material but many others are caused by organisms that occur naturally in the aquatic environment. Malnutrition is also considered a water-related disease; frequent diarrhea can interfere with intestinal uptake of vital nutrients from food. Water-related diseases generally attack the gastrointestinal tract, and symptoms may include diarrhea, nausea, vomiting, abdominal cramps, fever and weakness ("WHO | Water-related diseases," n.d.). Though water-related diseases are often misclassified as "waterborne diseases," the terms are not interchangeable. While waterborne diseases are transmitted only via the fecal-oral route, water-related diseases are transmitted in a variety of ways including washing of the skin or eyes or through insect vectors that breed in aquatic environments. Water, sanitation, and hygiene (WASH) interventions are shaped by route of transmission. Thus, an intervention for reducing waterborne disease may not simultaneously reduce water-related diseases (Threats, 2009).

Water-related diseases include waterborne diseases, but they also include tropical vector borne diseases such as malaria and yellow fever, diseases transported through aerosolized water

such as legionellosis, and water-washed diseases such as trachoma. Malaria, caused by four species of *Plasmodium* parasites, causes approximately 660,000 deaths each year. These deaths are primarily in Africa where a child dies every minute from malarial infection ("WHO | Malaria," n.d.). Trachoma is a debilitating disease caused by repeated infections of the bacteria *Chlamydia trachomatis,* which gradually turn the eyelashes of the infected inward, scratching the victim's cornea and producing scar tissue. Though trachoma is completely treatable and preventable, it still affects 150 million people each year, often resulting in visual impairment or total blindness (Kumaresan & Mecaskey, 2003).

Waterborne disease results from a specific microbial organism such as *Escherichia coli* (O157:H7), norovirus, hepatitis E virus, *Giardia lamblia*, *Cryptosporidium parvum*, and *Vibrio cholerae*, ("WHO | Emerging issues in water and infectious diseases," n.d.). Within low-income countries, diarrheal disease associated with waterborne illness is the second leading cause of death, outranking HIV/AIDS and malaria in the number of lives lost in 2008 ("WHO | The top 10 causes of death," n.d.). There are 2.5 billion cases of diarrheal disease each year among children alone. Although rotavirus is the most common cause of diarrheal disease, there is a higher risk of mortality from *Cryptosporidium* infections for immunocompromised children and adults ("WHO | Diarrhoea," n.d.).

Waterborne and/or water related disease burden in the Western Hemisphere

In the United States, surveillance of waterborne and water-related diseases primarily focuses on drinking water and recreational water outbreaks ("CDC - Surveillance Summaries for Waterborne Disease and Outbreaks," n.d.). From 2007 to 2008, over half of drinking water outbreaks were caused by some type of bacteria, particularly *Legionella* species, that appeared in potable water sources not intended for consumption ("Surveillance for Waterborne Disease

Outbreaks Associated with Drinking Water --- United States, 2007--2008," n.d.). The frequency of legionellosis in the U.S. is increasing rapidly, especially among travelers. The number of cases of legionellosis more than doubled between 2000 and 2009, and *Legionella* species account for roughly 18,000 hospitalizations per year ("Legionellosis --- United States, 2000--2009," n.d.). The majority of water-associated outbreaks in the United States originate from recreational water sources such as swimming pools and spas. Of the 134 recreational water outbreaks between 2007 and 2008, *Cryptosporidium spp.* was the most frequently reported source of infection ("Surveillance for Waterborne Disease Outbreaks and Other Health Events Associated with Recreational Water --- United States, 2007--2008," n.d.). *Cryptosporidium* is an extremely chlorine-resistant parasite that infects the intestinal tract, causing watery diarrhea and vomiting. *Cryptosporidium* has a low infectious dose, as few as 35 oocytes, compared to the thousands of oocytes shed in a few grams of fecal material. Easily dispersed through water and difficult to kill at typical swimming pool chlorine concentrations, *Cryptosporidium* will likely continue to be a problem in the United States (Shields, Hill, Arrowood, & Beach, 2008).

According to the World Health Organization, diarrheal disease in Canada accounts for just 0.2 disability-adjusted life-years (DALYs) annually ("WHO | Environmental burden of disease," n.d.). The variety of water-associated infections in Canada are comparable to other developed countries, but due to its low population density, more remote areas of Canada with large aboriginal communities may experience higher levels of waterborne illness as well as underreporting of those illnesses (Charron et al., 2004). Considering a large portion of Canada is covered by frozen tundra, Canadian waterborne disease research has some interest in the effects of global warming. A 2006 study of waterborne disease in southern Canada suggests extreme

rainfall resulting from climate change could significantly increase the region's risk for a waterborne disease outbreak (OR=2.283, CI=95%) (Thomas et al., 2006).

Latin American and Caribbean water-related disease epidemiology encompasses a wide spectrum of risk factors and diseases. The moist, tropical climates of these countries allow disease vectors to reproduce year-round (Sattenspiel, 2000). Although malaria in Latin America comprises less than 1% of the global disease burden, it still represents close to three million cases. Sixty-percent of all malaria cases reported in the Americas occur in Brazil where the Amazon rainforest shelters an abundance of malarial mosquito vectors (Arevalo-Herrera et al., 2012). Water-associated neglected tropical diseases like dengue fever are also endemic in Amazonian and non-Amazonian regions of Latin America ("Working to overcome the global impact of neglected tropical diseases," 2011). Unlike the United States and Canada, there are still many Latin Americans and Caribbean islanders without access to safe water or sanitation. According to the WHO World Statistics report in 2012, 14-15% of people in Peru, Nicaragua, Paraguay, and the Dominican Republic still do not have access to improved drinking water sources compared with just 4% in Mexico, Chile, and Saint Lucia. Improved sanitation coverage is extremely variable among Latin American countries. While only 5% of Costa Ricans lack access to improved sanitation, 73% of Bolivians and 48% of Nicaraguans use no improved sanitation method ("World Health Statistics 2012," 2012). These statistics parallel the diarrheal disease burdens in each country. While there are only 100 deaths per year from diarrheal disease in Costa Rica, there are 3, 400 deaths in Bolivia and 900 deaths in Nicaragua ("WHO | Environmental burden of disease," n.d.).

Waterborne and/or water related disease burden in Haiti

Of all countries in the western hemisphere, Haiti has the lowest rates of access to

improved drinking water and sanitation ("WHO | Progress on sanitation and drinking-water 2010 update," n.d.). Prior to the 2010 earthquake, only 70% of Haitians in urbanized areas and just over half of rural Haitians had access to improved water sources. Many Haitians do not have the resources to purchase water filtration devices, flocculants, or chemical treatments to clean contaminated water sources. Improved sanitation is also limited, with 49% of rural Haitians using open defecation as their primary sanitation method. ("CDC Washington Global Health E-Brief - 1st Quarter 2011," n.d.).

In Haiti, diarrheal disease is a leading cause of death for infants and children under the age of five ("UNICEF - At a glance," n.d.). During the recovery period following the earthquake, a rash of diarrheal disease, specifically cholera, reached epidemic proportions in October 2010, causing 470,000 cases of cholera and close to 7,000 deaths one year later ("CDC Global Health - Cholera in Haiti," n.d.). Cholera, almost non-existent in Haiti since the 1980's, is an infection of the intestines by *Vibrio cholerae,* commonly resulting in diarrhea and mild dehydration. Though severe cholera, characterized by extremely water stools, only occurs in 10% of patients, if it is left untreated, it can be fatal (Dowell & Braden, 2011) ("CDC - Cholera - General Information," n.d.).

Interventions in Water, Sanitation, and Hygiene (WASH)

Due to the ubiquity of water usage in daily household activities, there are many vectors for disease transmission, and therefore, many approaches to reducing water-related disease in a population. Good hand washing technique, covered in a health and hygiene curriculum, is effective at reducing acute respiratory infections and diarrheal disease. Learned hygiene behaviors, including the habitual use and maintenance of water treatment devices and sanitation facilities, are also a driving factor in the sustainability of a WASH intervention program, but further research is needed to understand the most effective ways to administer hygiene education

(Davis, Pickering, Rogers, Mamuya, & Boehm, 2011). Another benefit of hygiene education is that knowledge of health and hygiene behaviors can be shared within communities, impacting people outside the targeted population. An intervention intended to improve water treatment and hand washing in post-pregnancy women in Malawi found that friends and neighbors of good hand-washers were significantly more likely to also demonstrate proper hand washing technique (OR=2.2, CI=95%) (Russo et al., 2012).

Water quality interventions address contamination at the water source, in transit, or at point of use. Providing improved water sources, such as borehole wells with a hand pump, can reduce diarrheal disease, but in the countries with extremely limited access to safe water, these sources can also save time that would otherwise be used to collect and haul water (Jeuland & Whittington, 2009, p. -). Current research suggests WASH programs can also improve water quality substantially by utilizing household treatments, especially when water is transported in contaminated containers or collected to be stored for later use (Threats, 2009). A meta-analysis of 57 studies identifying bacterial contamination at both water source and point of use discovered that in the majority of cases, fecal and total coliform levels rose significantly after collection and transport (Wright, Gundry, & Conroy, 2004). Chlorination, chlorination-flocculation, solar disinfection, and filtration methods have been effective ways to address contamination at point of use (Lantagne, Quick, & Mintz, 2007).

Improved sanitation can take multiple forms, and choosing the appropriate sanitation method for a given region depends on the availability of local materials, funding, cultural preferences, hydrology, geology, soils, meteorology, and many other factors. As an example, a community in a dry, water-scarce region should not receive a pour-flush latrine intervention where up to three liters of water per use is required (Herron, 2007). Unlike health and hygiene

training or point of use treatments, improved sanitation interventions often require large initial investments. In Latin America and the Caribbean, initial costs can be as little as 52 United States Dollars (USD) for a ventilated improved pit latrine and as much as 160 USD for a sewer connection ("WHO | Evaluation of the costs and benefits of water and sanitation improvements at the global level," n.d.). Despite the high cost, improved sanitation interventions can reduce diarrheal morbidity by an average of 32% and these reductions can indirectly stimulate economic growth ("WHO | Securing sanitation," n.d.) (Van Minh & Nguyen-Viet, 2011).

Interventions in WASH Following Natural Disasters

Most information about water-related disease after a disaster is collected during emergency response efforts. Extreme flood events, often resulting from heavy rains or storm surge, can overwhelm water and sewage systems, flooding streets, homes, and unprotected or damaged drinking water sources with contaminated water. In 1988, severe flooding in Bangladesh resulted in the death, injury, or displacement of millions of people. A study of 46,740 patients who sought care from medical relief services during that time discovered diarrheal disease to be the leading cause of illness (34.7%) as well as the most common cause of death compared to drowning, injury, and respiratory tract infections. Cholera, endemic to Bangladesh, may have been a major source of infection in this disaster, but other pathogens such as *E.coli* 157:H7 have also been implicated in flooding events in Bangladesh (Siddique, Baqui, Eusof, & Zaman, 1991; Qadri et al., 2005). Additionally, sheltering thousands of displaced persons after a natural disaster can pose challenges for disease control. Despite extensive planning, shelter conditions can become overcrowded. Inadequate numbers of hand washing stations, laundry stations, and sanitation facilities may discourage safe hygiene practices. In 2005, in the aftermath of hurricane Katrina, approximately 1,000 evacuees from a 24,000-person

shelter complex in Houston, Texas were affected by norovirus. This outbreak was likely due to the extremely crowded conditions and an inability to quarantine sick patients ("Norovirus outbreak among evacuees from hurricane Katrina--Houston, Texas, September 2005," 2005).

Disaster events such as earthquakes or hurricanes are not directly associated with water-related disease outbreaks, but rather, they aggravate existing conditions such as limited access to improved drinking water sources by displacing large populations into areas with little public health infrastructure (Kouadio, Aljunid, Kamigaki, Hammad, & Oshitani, 2012). Disaster events can result in the displacement of people for years at a time, and there is a great need for long-term WASH interventions following emergencies. Emergency WASH programs have additional obstacles that may affect program outcomes such as overcrowding, lack of adequate nutrition, aid worker safety, and delays in access to raw materials or other physical resources ("Public Health Guide for Emergencies," n.d.). In 2004, an intervention using a commercial disinfectant-flocculant following flooding caused by Tropical Storm Jeanne demonstrated some of the difficulties in administering a WASH program post-disaster. First, due to slow mobilization of the distribution network, the disinfectant-flocculant treatment was initiated too late after flooding, and the water was no longer turbid enough to see the strongest benefit from flocculation. Second, the treatment was later found to be too expensive for the impoverished target population and thus, proved to be unsustainable (Colindres, Jain, Bowen, Mintz, & Domond, 2007). Another recent study examined various characteristics of household water treatments in Nepal, Indonesia, Kenya, and Haiti following major disasters. The study found that household treatments were somewhat effective at reducing bacterial contamination of drinking water, but more importantly, that the intervention was only effective if users were already using

contaminated sources and were already familiar with how to use the treatment method (Lantagne & Clasen, 2012).

Evaluation of WASH Following Natural Disasters

The Water, Engineering, and Development Centre at Loughborough University created a detailed manual on designing WASH intervention programs in response to an emergency situation. The manual covers everything from the initial environmental assessment to full implementation, but even within the suggested program design outline, there is no mention of a program evaluation (Harvey, Baghri, & Reed, 2002). A 2005 meta-analyses of water, sanitation, and hygiene interventions under non-emergency conditions found serious flaws in over half of the studies including issues with study design, exposure assessment, analytical methods, and gathering health data (Fewtrell et al., 2005) (Blum & Feachem, 1983). If emergency WASH programs are administered in more logistically complex situations, it is certainly possible that they also suffer from widespread methodological problems. The 2010 earthquake generated almost $10 billion dollars in foreign aid for the reconstruction of Haiti, including providing Haitians with improved sanitation and clean, sustainable water sources. Without systematic evaluations of the many WASH interventions already underway in Haiti, programs run the risk of wasting valuable financial resources that could be used to improve quality of life and reduce water-related disease (Adelman, 2011)

CHAPTER III

METHODOLOGY

This chapter addresses the study methodology, instrumentation, and data collection procedures used throughout the WASH program implementation in Haiti.

Procedures

The Samaritan's Purse WASH program began in March 2011. The WASH team included multiple program managers, coordinators, hygiene promoters, water technicians, lead construction masons, drivers and interns. A total of 26 communities within 4 communes (Petite Goave, Grand Goave, Léogâne, and Cabaret) were selected for the program based on water access to population density ratios (Fig. 1). These communities received one laundry pad, one bath house, and one drilled well with hand pump access. A total of 182 households (7 in each community) were originally selected to participate in the installation of household simple pit latrines with a Tippy Tap. The latrines were installed based on guidelines provided by the SPHERE Project, and the program required the head of each household to assist in the construction of his or her latrine. Four health and hygiene education sessions were conducted in all 26 communities. The curriculum of these sessions was developed using the World Health Organization's PHAST program guidelines.

Figure 1. SP Wash Program Procedures

Select Communes Select Communities	Recruit Households Enroll Particpants.	Construct laundry and bath facilities, well, and latrines	Conduct health and hygiene education sessions	One Month Follow-up Administer household and latrine surveys	Three Month Follow –Up Administer household and latrine surveys	Six Month Follow-up Administer household and latrine surveys

Measures

Data was entered electronically into two separate surveys (see Appendix) using the form-generating software Formstack on an Apple Ipod. Two separate follow-up surveys, a household survey and a latrine survey, were administered after the completion of all interventions. The surveys were administered in Haitian Creole by native-speaking interviewers and translated into English for the data analysis. Each survey lasted approximately 30 minutes. Some communities had already received the interventions, declined them, or could not receive them due to high groundwater tables or salty groundwater. In addition, the surveys from a few communities were not completed in time to be included in the data analysis. Thus, only 18 communities were included in the household survey, and 17 communities were included in the latrine survey.

A preliminary data set was made available on January 22, 2013 and was used to conduct the missing data analysis. The preliminary data set consisted of a household survey (N=884) and a latrine survey (N=109). A final data set, used for all other analyses, was made available on March 11, 2013. The final data set consisted of a household survey (N=1198) and a latrine survey (N=167). The household survey is considerably larger than the latrine survey. The latrine survey was only administered in households receiving a pit latrine while the household survey

included many households throughout each community. Data in the household survey included demographic information such as location of household, age and gender of respondent, and age ranges of household occupants. The average age of all respondents was 37.6 years old, and 69.1% of respondents were female. The data for the communities Bayre jedi, Cite bleu, and Pon soufrans appear only in the household survey. Data concerning primary water source, sanitation methods, bath house use, laundry pad use, observed hygiene behaviors, hygiene knowledge, attendance of health and hygiene education sessions, and spiritual impact were addressed in the household survey. The latrine survey included information about latrine use, Tippy Tap use, and reasons for under-utilization of these facilities. The communities Desca, Nan raket, Tierre sel, and Viau appear only in the latrine survey. Most of the variables in each data set were categorical or numeric. Numeric variables were collapsed into categorical variables for the analysis. Some categorical variables such as primary water source required only one response while others such as knowledge of diarrheal disease prevention allowed for multiple responses. Diarrheal disease was reported as the total number of cases in a household in the two weeks prior to the survey. A case was defined as having 3 or more liquid stools in a 24-hour period.

Statistical Analysis

The research questions for this thesis study were as follows:

1. Are the program goals of increasing access to potable water, improving sanitation, and improving hygiene behaviors being addressed by current data collection practices?

2. How can Samaritan's Purse improve their data collection process to further address these goals?

3. How are program inputs such as hand pump installation and hygiene education sessions impacting program outcomes?

To answer the first research question, descriptive statistics, including missing values, were analyzed across interviewer, across follow-up month, and across community to identify patterns and trends. The descriptive data by interviewer was used to identify potential inconsistencies in data collection practices and ensure the validity of the program data. Data stratified by community was used to understand how natural variations in program implementation among different communities might also affect data validity. Lastly, the descriptive data by follow-up month was used to observe changes in access to potable water and to determine if sanitation and hygiene behaviors improved over time.

In order to determine whether or not Samaritan's Purse could improve their data collection process, a critical examination was conducted to identify the potential assumptions and systematic errors that may undermine the internal validity of program data analyses. This examination was based on multiple interviews with field staff and program leads as well as a review of overall study design, field data collection practices, field notes, and inconsistencies within the descriptive statistics previously discussed.

Finally, the third research question was answered by examining program inputs (specifically attendance of health and hygiene sessions) and related associations with program outcomes such as sanitation and hygiene practices. Associations between household diarrheal disease prevalence and the use of program interventions were also examined. These analyses were conducted using Pearson's chi-squared goodness of fit test, which measures categorical variables. Chi-squared tests were run for all household survey data, but an identical set of chi-

squared tests were also run using data collected in the first follow-up month to eliminate the potential effect of duplicate responses from the same household over time.

The analysis of this data set was conducted in SPSS Version 20.0 (IBM Corporation, Armonk, NY). The researcher was approved by the Institutional Review Board of Georgia State University protocol #H12381, to examine de-identified secondary data shared by Samaritan's Purse of Canada.

CHAPTER IV - RESULTS

This chapter addresses the descriptive characteristics and statistical relationships of data collected following the WASH program implementation.

Analyses of Missing Data

Initial analysis of the data provided by Samaritan's Purse focused on determining the proportion of data that was missing. Missing data for the variables community name, date of interview, follow-up month, age ranges of household occupants is stratified by interviewer and presented in Table 1. Table 2 presents missing data concerning related latrine and Tippy Tap variables.

Table 1. Missing Household Variables Compared by Interviewer

Variable	Number Missing	Interviewer 1 (n=50)	Interviewer 2 (n=271)	Interviewer 3 (n=369)	Interviewer 4 (n=194)
	N (%)	n (%)	N (%)	n (%)	n (%)
Community	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Date	1 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)
Follow-up Months	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Males 0-4 yr	485 (54.9)	29 (6.0)	133 (27.4)	190 (39.2)	133 (37.4)
Females 0-4 yr	508 (57.5)	37 (7.30)	131 (25.8)	184 (36.2)	156 (30.7)
Males 5-18 yr	216 (24.4)	26 (12.0)	47 (21.8)	59 (27.3)	84 (38.9)
Females 5-18 yr	258 (29.2)	25 (9.70)	53 (20.5)	82 (31.8)	98 (38.0)
Males 19-54 yr	108 (12.2)	21 (19.4)	22 (20.4)	18 (16.7)	47 (43.5)
Females 19-54 yr	78 (8.8)	16 (20.5)	16 (20.5)	19 (24.4)	27 (34.6)
Males 55+ yr	492 (55.7)	36 (7.30)	98 (19.9)	207 (42.1)	151 (30.7)
Females 55+ yr	486 (55.0)	33 (6.80)	78 (16.0)	222 (45.7)	153 (31.5)

Within the initial household dataset, there were 884 surveys total. For community name and follow-up month there were no missing data. Only two interviews were missing a date. It is important to note that collection in the sixth follow-up month contributed only 4.4% or 39 of the administered household surveys. There are many observations missing for data associated with the question, “What is the total number of men/women (age range) living in the household in the past 3 months?” The percentage missing for this data ranges from 8.8% to almost 58%, and among interviewers, it ranges from 6.0% to 45.7%.

Table 2. Missing Values for Latrine and Tippy Tap Variables

Variable	Number Missing Total
	N (%)
# Using Latrine	9 (8.3)
Use of Tippy Taps (yes or no)	17 (15.6)
Tippy Tap Problems	16 (22.9)
Latrine Structure Problems	2 (1.8)

Within the initial latrine data set there were 109 surveys total. There were no missing values for community name, date, follow-up month, or number in household (range 1-20 occupants.) Eight households reported that "0" people were using the latrine, and the average number of latrine users was 6.14 with a range of 0 to 20 users. It is important to note that the sixth follow-up month does not appear in this data set and that the third follow-up month makes up only 19% of the 109 surveys. The last two variables – Tippy Tap Problems and Latrine Structure Problems – actually consist of multiple questions and answers. In these variables, "missing" was defined as no response among all possible answers. If at least one response was given from a household, then the data was *not* considered missing. Data was found missing for all four variables, but the questions regarding Tippy Taps had the greatest number of missing data points at 22.9%. Only 20.2% or 22 total households reported using the Tippy Tap

Descriptive Analyses of Household and Latrine Surveys Across Interviewer and Follow-up Month

This analysis is based on the final dataset (provided on March 11, 2013) and describes key outcome variables stratified by Interviewer and by Follow-Up Month respectively. The percentages observed in each table are the percent of positive responses reported by an individual

interviewer or recorded within each follow-up month. For example, Table 3 shows that among surveys conducted by Interviewer 1, there were 45.5% of households that reported using a laundry pad. Please note that the sample size indicated corresponds to the overall number of surveys conducted by each interviewer, however, this number fluctuates according to missing values observed by variable. This same caveat applies to follow-up month and community data. Unique patterns, observable differences, and trends over time are noted below each table.

A greater proportion of overall respondents reported using a bath house compared to a laundry pad. Of the 20.3% of respondents who reported using a laundry pad, 80.6% reported use of the laundry pad constructed by Samaritan's Purse. Of the 32.6% of respondents who reporting using a bath house, 79% reported using the Samaritan's Purse bath house. Most respondents identified their primary water source as a hand pump (61.1%). A little over half (56%) of households reported attending at least one of the four health and hygiene education sessions.

Table 3. Household survey variables stratified by interviewer.

Variable	Name of Interviewer			
	Interviewer 1 (N=50)	Interviewer 2 (N=323)	Interviewer 3 (N=512)	Interviewer 4 (N=313)
	n (%)	n (%)	n (%)	n (%)
LAUNDRY AND BATH HOUSE				
Using Laundry Pad (N= 1180)	20 (45.5)	98 (30.7)	97 (19.1)	28 (9.0)
Using SP Laundry Pad (N= 242)	1 (5)	79 (80.6)	90 (93.8)	25 (89.3)
Using Bath House (N= 1183)	15 (34.1)	146 (45.9)	151 (29.7)	74 (23.7)
Using SP Bath House (N=386)	15 (100)	136(93.2)	125 (82.8)	29 (39.2)
WATER SOURCE				
Surface Water as Primary Source (N=1191)	8 (18.2)	7 (2.2)	3 (0.6)	0 (0)
Hand Pump as Primary Source (N=1191)	6 (13.6)	221 (68.4)	480 (93.9)	25 (8.0)
Walking >15 min for Water (N=1183)	12 (30)	238 (74.1)	429 (84.0)	94 (30.2)
LATRINE				
No Latrine (N=1186)	1 (2.3)	97 (30.2)	58 (11.4)	51 (16.4)
Using Improved Sanitation (N=1186)	29 (65.9)	209 (65.1)	423 (82.9)	205 (65.9)
Using Household Latrine (N=966)	4 (9.5)	163 (74.1)	345 (77.2)	189 (73.5)
HEALTH AND HYGIENE				
Attending Any H&H Session (N=1183)	29 (65.9)	254 (79.9)	275 (54)	104 (33.3)
Attending All H&H Sessions (N=538)	15 (51.7)	85 (33.6)	117 (42.5)	18 (17.5)
Soap Available (N=895)	29 (90.6)	235 (79.1)	311 (85.9)	178 (87.3)
Proper Hand washing Technique (N=1186)	3 (6.8)	145 (45.3)	349 (68.6)	3 (1.0)
HOUSEHOLD DIARRHEAL DISEASE				
Diarrhea in children <5 years old (N=996)	13 (37.1)	25 (8.2)	31 (6.6)	22 (11.7)
Diarrhea in Persons >5 years old (N=1184)	7 (15.9)	32 (10)	27 (5.3)	23 (7.3)
SPIRITUAL IMPACT				
Households Spiritually Impacted (N=1108)	9 (50)	170 (54.5)	211 (44.2)	196 (65.1)
Households More Involved With Church (N=1178)	6 (13.6)	56 (17.7)	11 (2.2)	35 (11.3)

Laundry and bath house. The percent of households using laundry pads was low to moderate (ranging from 9.0-45.5%), but with the exception of Interviewer 1, who conducted only 50 surveys total, most interviewers reported high rates (80.6% and up) of SP laundry pad use among laundry pad users. The percent of households using a bath house was slightly higher among most interviewers compared to laundry pads, again with the exception of surveys from Interviewer 1. Concerning the percent of households using an SP bath house, only Interviewer 4 reported a moderate utilization rate (39.2%).

Water source. The percent of households using surface water as their primary source was quite low with Interviewer 1 reporting the highest percentage (18.2%). Interviewer 2 and Interviewer 3 reported high utilization rates (68.4% and 93.9% respectively) for the hand pump. The other two interviewers reported very low rates, especially Interviewer 4 (8.0%). This same trend was observed among households that walked more than 15 minutes to collect water. Interviewer 2 and Interviewer 3 reported high rates of households that walk over 15 minutes to get water while Interviewer 4 reported moderate rates.

Latrine. Interviewer 1 reported the lowest relative rates for all variables concerning latrine use, and there are no surveys conducted by Interviewer 1 in the Latrine Data set. Interviewer 2 reported the highest percentage of households not using any type of latrine (30.2%.) Aside from Interviewer 1, all three interviewers demonstrated consistency in reporting household latrine use (73.5-77.2%). The data for household latrine use is derived from the question, "Where is the latrine located?" Two households from surveys by Interviewer 1 and Interviewer 2 reported using latrines located both in their household and at a neighbor's household.

Health and hygiene. Interviewer 2 reported the highest attendance rates for any H&H session (79.9%). It should be noted that Interviewer 4 reported the lowest rates of attendance for the H&H sessions (33.3% for one or more sessions and 17.5% for all sessions). These same households had a correspondingly low rate of proper hand washing technique despite having soap availability comparable to other communities in the survey.

Household diarrheal disease. Among the last three interviewers, diarrhea in children younger than 5 years old was reported at prevalences of .6%, 8.2 %, and 11.7%. Please note that these numbers reflect the prevalence of diarrhea at the household level. Almost all household reports consisted of either 1 or 2 cases of disease, 69% and 21% respectively. One household had 5 cases of diarrheal disease, which was reported by Interviewer 4 in Haut Damier in the first follow-up month.

Spiritual Impact. Interviewer 3 reported the lowest rates of households more involved with their place of worship (2.2%) as well as households who were spiritually impacted by the project (44.2%.).

Table 4. Household survey variables stratified by follow-up month.

Variable	Month of Follow-up		
	Month One (N= 730)	Month Three (N=310)	Month Six (N=158)
	n (%)	n (%)	n (%)
LAUNDRY AND BATH HOUSE			
Using Laundry Pad (N= 1180)	190 (26.5)	40 (13)	13 (8.3)
Using SP Laundry Pad (N= 242)	142 (75.1)	40 (100)	13 (100)
Using Bath House (N= 1183)	283 (39.3)	78 (25.6)	25 (15.9)
Using SP Bath House (N=386)	217 (76.7)	70 (89.7)	18 (72)
WATER SOURCE			
Surface Water as Primary Source (N=1191)	13 (1.8)	3 (1.0)	2 (1.3)
Hand Pump as Primary Source (N=1191)	425 (58.7)	193 (62.5)	114 (72.2)
Walking >15 min for Water (N=1183)	431 (60.1)	202 (65.6)	140 (88.6)
LATRINE			
No Latrine (N=1186)	142 (19.7)	60 (19.5)	5 (3.2)
Using Improved Sanitation (N=1186)	493 (68.4)	231 (75.2)	142 (89.9)
Using Household Latrine (N=966)	405 (71.2)	196 (80)	100 (65.8)
HEALTH AND HYGIENE			
Attending Any H&H Session (N=1183)	420 (58.5)	164 (53.4)	78 (49.4)
Attending All H&H Sessions (N=538)	156 (37.2)	54 (33.1)	25 (32.1)
Soap Available (N=895)	420 (78.9)	232 (90.6)	101 (94.4)
Proper Hand washing Technique (N=1186)	273 (37.9)	117 (38.1)	110 (69.6)
HOUSEHOLD DIARRHEAL DISEASE			
Diarrhea in children <5 years old (N=996)	71 (11.5)	15 (6.0)	5 (3.9)
Diarrhea in Persons >5 years old (N=1184)	66 (9.2)	19 (6.2)	4 (2.5)
SPIRITUAL IMPACT			
Households Spiritually Impacted (N=1108)	381 (57.4)	158 (54.1)	47 (30.9)
Households More Involved With Church (N=1178)	88 (12.3)	19 (6.2)	1 (0.6)

Laundry and bath house. There are a few notable trends in laundry pad and bath house use over time. First, the amount of surveys completed dropped significantly after Month One (N=730) and then again after Month Three (N=310). Month Six (N=158) had the lowest number of surveys. Second, overall laundry pad and bath house use decreased over time. SP laundry pad use remained high throughout all follow-up months, but SP bath house use decreased after the third month follow-up.

Water source. The percent of households using surface water as their primary source was consistently low over time (1.8%, 1.0%, 1.3%.) The percent of households using the hand pumps as a primary source increased slightly over all follow-up months. At the same time, the number of households walking more than 15 minutes to retrieve water also increased. There is no obvious trend among households with a household latrine, but there is an increase in the percentage of households using some form of improved sanitation over time.

Health and hygiene. There is some relative consistency in attendance of any or all Health and Hygiene sessions across follow-up months, but attendance does appear to decrease slightly over time. The reverse trend is observed for soap availability and even more dramatically, for demonstration of proper hand washing technique, which starts at 37.9% in the first month and increases to 69.6% in the sixth month.

Household diarrheal disease. Household diarrheal disease prevalence decreased over time in both age categories.

Spiritual impact. Households reporting spiritual impact or increased church involvement decreases over the follow-up period. Only a small proportion of households report being more involved in their place of worship.

This analysis is based on the final data set and describes key outcome variables stratified by Interviewer and by Follow-Up Month respectively. The percentages observed in the table below are the percent of positive responses reported by an individual interviewer or recorded within each follow-up month. Unique patterns, observable differences, and trends over time are noted below each table.

Table 5. Latrine survey variables stratified by interviewer and follow-up month.

Variable	Name of Interviewer				Month of Follow-up		
	Interviewer 1 (N=50)	**Interviewer 2 (N=323)**	**Interviewer 3 (N=512)**	**Interviewer 4 (N=313)**	**Month One (N= 730)**	**Month Three (N=310)**	**Month Six (N=158)**
Using SP Latrine (N=151)	ND	24 (85.7%)	59 (100%)	60 (93.8%)	96 (96%)	28 (87.5%)	19 (100%)
Using Tippy Tap (N=130)	ND	6 (20%)	9 (39.1%)	9 (11.7%)	19 (20.7%)	4 (12.9%)	1 (14.3%)

In the latrine data set, there were no surveys conducted by Interviewer 1. The percent of households using an SP latrine was quite high across interviewer and over time, but the percent using the Tippy Tap was moderate to low. Use of the SP latrine and use of the Tippy Tap decreased from month one to month three but increased slightly from month three to month six.

Descriptive Analyses of the Household and Latrine Surveys Across Community

This analysis is based on the final data set and describes key outcome variables stratified by Community. The percentages observed in the table below are the percent of positive responses reported by an individual interviewer or recorded within each follow-up month. Unique patterns, observable differences, and trends over time are noted below the following tables.

Table 6. Household survey variables stratified by Anana, Anba bazil, Bayre jedi, Cite Bleu, Fondou and Foveau communities.

Variable	Anana (N=79)	Anba bazil (N=40)	Bayre jedi (N=120)	Cite Bleu * (N=86)	Fondou (N=40)	Foveau * (N=80)
LAUNDRY AND BATH HOUSE						
Laundry Pad Use (N= 1180)	20 (26%)	17 (42.5%)	32 (26.7%)	19 (23.8%)	15 (37.5%)	2 (2.5%)
SP Laundry Pad Use (N= 242)	18 (90%)	17 (100%)	25 (78.1%)	0 (0%)	14 (93.3%)	2 (100%)
Bath House Use (N=1183)	40 (51.3%)	18 (45%)	33 (27.7%)	13 (16.5%)	12 (30%)	10 (12.5%)
SP Bath House Use (N=386))	37 (92.5%)	17 (94.4%)	28 (84.8%)	13 (100%)	12 (100%)	2 (20%)
WATER SOURCE						
Hand Pump as Primary Source (N=1191)	79 (100%)	38 (95%)	117 (97.5%)	3 (3.8%)	31 (77.5%)	12 (15%)
HYGIENE						
Attending any H&H session (N=1183)	53 (67.1%)	24 (60%)	61 (51.7%)	46 (57.5%)	24 (60%)	13 (16.2%)
Attending all H&H sessions (N=660)	13 (24.5%)	10 (41.7%)	20 (32.8%)	19 (41.3%)	10 (41.7%)	0 (0%)
DIARRHEAL DISEASE						
Diarrhea in children <5 years old (N=996)	3 (3.8%)	1 (2.9%)	9 (7.8%)	12 (20.3%)	1 (2.7%)	5 (12.8%)
Diarrhea in Persons >5 years old (N=1184)	2 (2.5%)	1 (2.5%)	8 (6.8%)	7 (8.8%)	2 (5.0%)	6 (7.5%)

* Communities in the Cabaret region

Table 7. Household survey variables stratified by Gabyon, Haut Damier, Mahaie, Masketi, Mayonbe, and Mon chez communities.

Variable	Gabyon (N=41)	Haut Damier* (N=32)	Mahaie* (N=40)	Masketi (N=40)	Mayonbe (N=83)	Mon chez (N=36)
LAUNDRY AND BATH HOUSE						
Laundry Pad Use (N= 1180)	7 (17.5%)	0 (0%)	7 (17.5%)	22 (55%)	3 (3.7%)	12 (33.3%)
SP Laundry Pad Use (N= 242)	7 (100%)	ND	6 (85.7%)	10 (45.5%)	2 (66.7%)	11 (100%)
Bath House Use (N=1183)	11 (26.8%)	6 (18.8%)	12 (30%)	23 (57.5%)	25 (31.6%)	12 (33.3%)
SP Bath House Use (N=386))	10 (90.9%)	0 (0%)	2 (16.7%)	22 (95.7%)	23 (92%)	12 (100%)
WATER SOURCE						
Hand Pump as Primary Source (N=1191)	39 (95.1%)	2 (6.2%)	9 (22.5%)	0 (0%)	77 (93.9%)	36 (100%)
HYGIENE						
Attending any H&H session (N=1183)	28 (68.3%)	2 (6.2%)	11 (28.2%)	34 (87.2%)	61 (75.3%)	17 (47.2%)
Attending all H&H sessions (N=660)	17 (60.7%)	0 (0%)	1 (9.1%)	9 (26.5%)	29 (47.5%)	5 (29.4%)
DIARRHEAL DISEASE						
Diarrhea in children <5 years old (N=996)	5 (12.8%)	4 (22.2%)	1 (5.6%)	4 (12.5%)	4 (5.1%)	3 (9.1%)
Diarrhea in Persons >5 years old (N=1184)	10 (24.4%)	7 (21.9%)	3 (7.5%)	7 (17.5%)	6 (7.4%)	1 (2.8%)

* Communities in the Cabaret region

Table 8. Household survey variables stratified by Nan bannann, Nan dal, Nan moran, Pon Soufrons, and Sentandre communities.

Variable	Nan Bannann * (N=82)	Nan dal (N=136)	Nan moran (N=34)	Nan woch* (N=79)	Pon Soufrons (N=40)	Sentandre (N=110)
LAUNDRY AND BATH HOUSE						
Laundry Pad Use (N= 1180)	1 (1.2%)	9 (6.7%)	9 (26.5%)	18 (22.8%)	21 (52.5%)	29 (26.9%)
SP Laundry Pad Use (N= 242)	0 (0%)	8 (88.9%)	9 (100%)	17 (94.4%)	21 (100%)	28 (96.6%)
Bath House Use (N=1183)	20 (24.4%)	41 (30.4%)	17 (51.5%)	30 (38%)	24 (60%)	39 (35.5%)
SP Bath House Use (N=386))	2 (10%)	31 (75.6%)	15 (88.2%)	25 (83.3%)	24 (100%)	30 (26.9%)
WATER SOURCE						
Hand Pump as Primary Source (N=1191)	0 (0%)	111 (81.6%)	34 (100%)	2 (2.5%)	36 (90%)	106 (96.4%)
HYGIENE						
Attending any H&H session (N=1183)	56 (68.3%)	72 (53.3%)	26 (76.5%)	37 (46.8%)	23 (57.5%)	74 (68.5%)
Attending all H&H sessions (N=660)	9 (16.7%)	30 (41.7%)	11 (42.3%)	12 (32.4%)	10 (43.5%)	30 (40.5%)
DIARRHEAL DISEASE						
Diarrhea in children <5 years old (N=996)	9 (11.8%)	6 (5.2%)	3 (9.4%)	5 (10.2%)	3 (8.1%)	13 (12.3%)
Diarrhea in Persons >5 years old (N=1184)	10 (12.2%)	2 (1.5%)	4 (11.8%)	4 (5.1%)	0 (0%)	9 (8.3%)

* Communities in the Cabaret region

The following results correspond to Tables 6-8 above.

Laundry and bath house. Rates of overall laundry pad use were highest for Pon Soufrons (52.5%) and Masketi (55%). The percent of households reporting SP laundry pad use was high overall – at least six communities reported 100% of laundry pad-users were using an SP laundry pad. Haut Damier reported no overall laundry pad users and no data was provided for SP laundry pad use. This same community also reported only 18.8% bath house users and no SP bath house users. Nan Bannann is another community that reported similarly low rates of overall and SP

facility use. Concerning laundry pad use, there were some values missing for the following communities: Anana, Cite Bleu, Gabyon, Haut Damier, Mahaie, Mayonbe, Nan Bannaan, and Sentadre. Concerning bath house use, there were some values missing for the following communities: Bayre Jedi, Cite Bleu, Mayonbe, Nan Dal, and Nan Moran.

Water source. Use of the hand pump as a primary water source varies across communities. Nan woch, (2.5%), Haut Damier (6.2%), Cite Bleu (6.5%), Nan Woch (3.8%), Foveau (15%), Masketi (0%) and Nan Bannaan (0%) have particularly low rates. These sites are all in the Cabaret commune. Salty groundwater was reported in this region, which may explain the drop in hand pump usage.

Health and hygiene. Attendance of any or all H&H sessions was lowest in the communities Haut Damier (6.2% and 0%), Mahaie (28.2% and 9.1%), and Foveau (16.2% and 0%) respectively. These communities are all located in the Cabaret commune. No community reported attendance rates higher than 87.2% for any H&H session. Attendance for all 4 H&H sessions is relatively low with Gabyon (60.7%) reporting the highest. Concerning health and hygiene session attendance, there were some missing values for the following communities: Bayre Jedi, Cite Bleu, Mahaie, Mayonbe, Nan Dal, and Sentadre.

Diarrheal Disease. Households reporting cases of diarrheal disease appears somewhat consistent among communities. Haut Damier (22.2%) reports the highest percent of households with diarrheal disease in children <5 years old while Gabyon (24.4%) reports the highest percent in person >5 years old. Rates of diarrheal disease for young children within households are higher than for older children/adults in 10 of the 15 of the communities. Concerning diarrheal prevalence among young children, there were some missing values for every community with

Haut Damier and Mahaie having close to half of responses missing. Concerning diarrheal prevalence among older children and adults, there were some missing values for the following communities: Bayre Jedi, Cite Bleu, Mayonbe, and Sentadre.

Table 9. Latrine survey variables stratified by community.

Variable	Anana (N=14)	Anba bazil (N=7)	Desca* (N=7)	Fondou (N=7)	Foveau* (N=14)	Gabyon (N=7)
SANITATION						
Using SP Latrine (N=151)	14 (100%)	7 (100%)	6 (100%)	7 (100%)	13 (100%)	7 (100%)
Using Tippy Tap (N=130)	6 (54.5%)	2 (100%)	3 (42.9%)	ND	2 (14.3%)	4 (66.7%)

Variable	Haut Damier* (N=7)	Mahaie* (N=9)	Masketi (N=3)	Nan Bannann* (N=21)	Nan dal (N=12)	Nan moran (N=7)
SANITATION						
Using SP Latrine (N=151)	5 (100%)	8 (100%)	ND	18 (90%)	12 (100%)	7 (100%)
Using Tippy Tap (N=130)	0 (0%)	0 (0%)	0 (0%)	4 (19.0%)	2 (40%)	ND

Variable	Nan raket (N=7)	Nan woch* (N=14)	Sentandre (N=19)	Terre sel* (N=7)	Viau* (N=5)
SANITATION					
Using SP Latrine (N=151)	7 (100%)	10 (71.4%)	17 (89.5%)	5 (100%)	ND
Using Tippy Tap (N=130)	0 (0%)	1 (7.1%)	0 (0%)	0 (0%)	0 (0%)

*Communities in the Cabaret region

The percent of households using an SP latrine was mostly very high – 12 of the communities report that among latrine users, 100% were using SP latrines. Nan Woch (71.4%) reported the lowest percentage of SP latrine users. Tippy Tap usage was extremely variable and generally low across communities. The communities Viau and Masketi provided no data regarding SP latrine use, and the communities Nan moran and Fondou provided no data regarding Tippy Tap use. Concerning latrine use, there were some missing values for the

following communities: Desca, Haut Damier, and Mahaie. Concerning Tippy Tap use, there were some missing values for the following communities: Anana, Anba Bazil, Gabyon, and Nan Dal.

Tests of Statistical Significance for Health and Hygiene Session Attendance and Household Diarrheal Disease Prevalence from the Final Data Set

This analysis is based on the final data set and describes the statistical relationships between attendance of health and hygiene (H&H) sessions and program outcomes as well as the relationships between diarrheal disease and program interventions. Statistically significant relationships are discussed below each table.

Table 10. Associations of H&H Session Attendance with Program Outcomes

Outcomes	Attended Any H&H's	Did Not Attend Any H&H's	P-value
	n (%)	n (%)	
LAUNDRY AND BATH HOUSE			
Using Laundry Pad	182 (27.8)	57 (11)	.000*
Using SP Laundry Pad	150 (82.4)	42 (75)	.219
Using Bath House	271 (41.1)	113 (21.9)	.000*
Using SP Bath House	242 (89.3)	61 (54)	.000*
WATER SOURCE			
Surface Water as Primary Source	13 (2)	5 (1)	.161
Hand Pump as Primary Source	447 (67.5)	278 (53.4)	.000*
Walking >15 min for Water	451 (68.5)	317 (61.3)	.01*
LATRINE			
No Latrine	134 (20.2)	71 (13.6)	.003*
Using Improved Sanitation	484 (73.1)	378 (72.6)	.83
Using Household Latrine	367 (70.3)	333 (75.5)	.071
HOUSEHOLD DIARRHEAL DISEASE			
Diarrhea in children <5 years old	55 (9.3)	36 (9)	.851
Diarrhea in Persons >5 years old	54 (8.2)	34 (6.5)	.286
HYGIENE BEHAVIORS			
Soap Available	458 (84.5)	293 (83.7)	.753
Proper Handwashing Technique	322 (48.7)	176 (33.8)	.000*
Describe 5 ways to prevent diarrhea	292 (44.1)	190 (36.5)	.009*

*Statistically significant

Laundry and bath house. Attending any of the four H&H sessions was strongly associated with overall laundry pad and bath house use as well as SP bath house use. Of those who attended any health and hygiene session, 89.4% reported using the SP bath house.

Water source. Attendance was positively associated with hand pump use but also with walking greater than 15 minutes to a water source.

Latrine. Slightly more attendees reported not using any type of latrine, and this relationship was statistically significant. Of households attending at least one H&H session, 68.5% reported using the hand pump as their primary water source

Household diarrheal disease. There was no relationship between hygiene education and diarrheal prevalence across both age categories.

Hygiene behaviors. Attendance was strongly associated with demonstrating proper hand washing technique and knowledge of diarrheal disease prevention. Attending any session was positively associated with these good hygiene behaviors. Attendance had no effect on soap availability.

Table 11. Associations of household diarrheal prevalence with use of program interventions

Interventions	Diarrhea <5	No Diarrhea <5	P-value	Diarrhea >5	No Diarrhea >5	P-value
	n (%)	n (%)		n (%)	n (%)	
Laundry Pad Use	26 (29.2)	192 (21.4)	.89	19 (7.9)	220 (92.1)	.721
SP Laundry Pad Use	19 (73.1)	156 (81.7)	.298	13 (6.8)	179 (93.2)	.159
Bath House Use	36 (39.6)	299 (33.3)	.226	34 (8.9)	350 (91.1)	.241
SP Bath House Use	28 (77.8)	242 (80.9)	.651	28 (9.2)	275 (90.8)	.606
Hand Pump Use	48 (52.7)	620 (68.5)	.002*	46 (6.3)	679 (93.7)	.055
Improved Sanitation	58 (63.7)	662 (73.1)	.056	51 (5.9)	812 (94.1)	.001*

*Statistically significant

There were few statistically significant relationships between diarrheal prevalence and intervention use. Laundry pad and bath house use had no impact on household diarrheal disease. Among households reporting no cases of diarrheal disease in children under five, 68.5% reported using the hand pump as their primary water source. For households reporting no cases of diarrheal disease in older children and adults, 94.1% reported using improved sanitation compared to just 5.9% in households reporting diarrhea. For the hand pump and improved

sanitation variables, even the non-significant relationships to diarrheal disease – p=0.56 in under five years old and p=0.55 in over five years old – were also relatively strong.

Tests of Statistical Significance for Health and Hygiene Session Attendance and Household Diarrheal Disease Prevalence at the 1-Month Post Installation Visit

This analysis is based on the final data set, selecting only for data collected within the first follow-up month. The analysis describes the statistical relationships between attendance of health and hygiene sessions and program outcomes as well as the relationships between diarrheal disease and program interventions. Statistically significant relationships are discussed below each table.

Table 12. Associations of H&H Session Attendance with Program Outcomes at 1-Month Post Installation Visit

Outcomes	Attended Any H&H's	Did Not Attend Any H&H's	P- value
	n (%)	n (%)	
LAUNDRY AND BATH HOUSE			
Using Laundry Pad	139 (33.4)	48 (16.2)	.000*
Using SP Laundry Pad	107 (77)	33 (70.2)	.353
Using Bath House	199 (47.5)	82 (27.5)	.000*
Using SP Bath House	179 (89.9)	36 (43.9)	.000*
WATER SOURCE			
Surface Water as Primary Source	9 (2.1)	4 (1.3)	.428
Hand Pump as Primary Source	279 (66.4)	141 (47.3)	.000*
Walking >15 min for Water	271 (65.0)	157 (53.4)	.002*
LATRINE			
No Latrine	90 (21.4)	51 (17.1)	.152
Using Improved Sanitation	295 (70.2)	195 (65.4)	.173
Using Household Latrine	217 (66.6)	187 (77.6)	.004*
HOUSEHOLD DIARRHEAL DISEASE			
Diarrhea in children <5 years old	42 (10.9)	29 (12.5)	.549
Diarrhea in Persons >5 years old	36 (8.6)	29 (9.7)	.593
HYGIENE BEHAVIORS			
Soap Available	279 (81.6)	140 (74.5)	.054
Proper Handwashing Technique	197 (46.9)	75 (25.2)	.000*
Describe 5 ways to prevent diarrhea	159 (37.9)	88 (29.5)	.021*

*Statistically significant

Laundry and bath house. Similar to the overall chi-squared analysis for health and hygiene session attendance, attendance was strongly associated with overall laundry pad and bath house use as well as SP bath house use.

Water source. The results for water source are also similar between the two chi-squared analyses. Attendance was positively associated with hand pump use but also with walking

greater than 15 minutes to a water source. 66.4% of attendees reported using the hand pump compare to 47.3% in non-attendees.

Latrine. Unlike in the overall analysis, households attending any of the sessions were less likely to report using a household latrine (66.6%) compared to non-attending households (77.6%). Session attendance is also no longer associated with non-latrine users.

Household diarrheal disease. There are still no significant relationships between diarrheal disease and health and hygiene session attendance.

Hygiene behaviors. As in the overall analysis, attendance was positively associated with proper hand washing technique and knowledge of diarrhea prevention. Attendance had no effect on soap availability. 46.9% of attending households demonstrated proper hand washing technique, and 37.9% of attendees were knowledgeable of diarrheal disease prevention.

Table 13. Associations of household diarrheal prevalence with use of program interventions at 1-Month Post Installation Visit

Interventions	Diarrhea <5	No Diarrhea <5	P-value	Diarrhea >5	No Diarrhea >5	P-value
	n (%)	n (%)		n (%)	n (%)	
Laundry Pad Use	19 (27.5)	151 (27.8)	.969	13 (20.3)	175 (26.9)	.255
SP Laundry Pad Use	12 (63.2)	115 (76.7)	.199	7 (53.8)	134 (77)	ND
Bath House Use	30 (42.3)	220 (40.2)	.742	26 (39.4)	256 (39.1)	.968
SP Bath House Use	22 (73.3)	176 (80.0)	.399	21 (80.8)	195 (76.2)	.598
Hand Pump Use	34 (47.9)	355 (64.8)	.006*	36 (54.5)	386 (58.9)	.491
Improved Sanitation	45 (63.4)	375 (68.4)	.391	39 (59.1)	453 (69.2)	.094

*Statistically significant

A chi-squared test could not be performed for household diarrheal prevalence as it related to SP laundry pad use. As in the overall analysis, diarrheal disease in children under the age of

five is significantly lower among hand pump users. The significant relationship between using improved sanitation and diarrheal disease prevalence in older children and adults disappears after selecting for month one data.

CHAPTER V

CONCLUSION

Addressing Program Goals

To answer the question, "Are the program goals of increasing access to potable water, improving sanitation, and improving hygiene behaviors being addressed by current data collection practices?" this evaluation examined descriptive statistics, including missing values. In the missing data analysis conducted using the initial data set, there were large numbers of missing values for variables associated with the question, "What is the total number of men/women (age range) living in the household in the past 3 months?" More than half of all age data was missing for males and females in the age ranges 0-4 years old and 55+ years old. Based on discussions with field staff, interviewers used a "0" to represent households without members in a given age category, so it is not clear why there were so many missing values for these age categories. Within the descriptive analyses, there was considerable variability across interviewers in both surveys. This evaluation could not determine if the differences were attributable to interviewer inconsistency or to variability in the communities in which they worked. The variables for interviewer and community are, in most cases, linked, meaning neither value can be independently evaluated. With one exception, interviewers did not share work within a community for latrine surveys. This differs from household data that regularly involved

surveys from multiple interviewers in the same community. Even within household data, there is some interviewer-community association, because Interviewer 2 and Interviewer 3, regularly shared the same communities while Interviewer 4 did not share communities. Alternatively, variations between communities cannot be evaluated. The Cabaret region, which included the communities Cite bleu, Desca, Foveau, Haut Damier, Mahaie, Nan Bannann, Nan woch, Terre sel, and Viau, reported some of the lowest proportions of bath house and laundry pad use, hand pump use, and health and hygiene attendance. Due to the non-random association of community and interviewer, it is unknown if these findings are attributable to the assigned interviewer or to the community itself.

Data collection practices also do not address the goals of achieving increases in access to water, sanitation, and hygiene over time. The sample size for each follow-up period decreases over time, beginning with 730 surveys in month one and dropping to 158 surveys by month six. All households sampled in month three and month six may not be representative of the original month one sample, so it is necessary to examine changes in individual households. Households were assigned a number identifying their community of residence, but they were not assigned an individual ID number or any other type of identifier. Even after attempting to sort households by demographic data, individual households could not be identified from one follow-up to the next. Thus, it is not possible to track individual household behaviors through time and not possible to understand how program interventions influenced behavior change throughout all follow-up periods. Health and hygiene session attendance appears to decrease between month one and month six, whereas the use of improved sanitation increases. Due to the drastic changes in sample size and the inability to track individual households, this evaluation could not determine

the validity of these trends. Trends within household and latrine survey data were observed but remain limited by this issue.

Lastly, more information is needed to understand how to improve utilization of the Tippy Tap. Tippy Tap use was high for only a few communities. The majority of communities reported a usage rate between 40% and 0%. The latrine survey included a question about reasons for non-use of the Tippy Tap, and the most frequent response to this question was "Other." A subsequent write-in explanation field for non-specific responses was not included in the survey.

Future Recommendations

There are several ways in which Samaritan's Purse can improve their data collection process to address their program goals. Changes in data collection parameters or collection software can reduce missing data during collection efforts. Selecting electronic collection methods that prompt users to fill in or comment on missing values in the field will encourage form completion and eliminate unexplained missing or non-specific data. To fully understand the impact of program interventions over time, future data collection efforts should assign a unique ID to individual households or if the home itself is transient, perhaps to individual heads of households. A household identification number would also allow analysis between survey data sets. Matched households could be selected within both the latrine and household surveys, allowing for greater in-depth analysis of SP latrine and Tippy Tap use. In addition, it is important to understand the reasons for participant attrition over the follow-up period. Understanding the differences between households that completed the study and those that did not will inform future WASH studies. If funding becomes available, a study that evaluates households that did

not complete the program may be beneficial. This additional study may identify unexpected critical needs such as access to medical services that can limit WASH program sustainability.

To evaluate consistency among interviewers, it is first recommended that interviewers receive a randomized assignment of households within community. If randomization is not possible, there are additional ways WASH programs can evaluate interviewer consistency. Establishing a quality assurance feedback loop, similar to one described in Gassman et. al., can be used to correct inconsistency in data collection practices (Gassman, Owen, Kuntz, Martin, & Amoroso, 1995). A feedback loop in this type of study may involve providing interviewers with a weekly summary of their collection efforts, including noting any missing values, misinterpretations, and erroneous responses. Using real-life simulations of data collection sites can be also be used as both a training exercise and to compare interviewer response patterns. Using scenario-based training, corrections to data collection practices can be done in an educational, low-pressure environment. In summary, Samaritan's Purse may benefit from enhancing their program in a number of areas, including, but not limited to: staff, information collection systems, study protocol, and root cause analysis regarding attrition

Program Outcomes

This evaluation found a number of statistically significant associations between the use of program interventions and program outcomes. To account for the possibility of households reporting the same data multiple times during the follow-up period, a second analysis was conducted using only data from follow-up month one. Month one results are the focus of this discussion. Attendees of any health and hygiene session were much more likely to use the SP bath house. Hygienic bathing and laundering may protect people from exposure to water-washed

disease agents. According to a 2006 study of schistosomiasis in rural Brazil, bathing results in water-contact with 99.64% of the body, and washing clothes represents the longest consecutive daily exposure to water. These findings stress the importance of bathing and laundering interventions to reduce the burden of cutaneous water-related disease (Helmut Kloos et al., n.d.). Of session attendees, a majority reported using the hand pump as their primary water source. Hand pump use was also significantly lower among households reporting diarrhea in children under the age of five. Access to improved water sources such as protected wells has already been shown to reduce the risk of childhood diarrhea and attenuate the various sequalae of malnutrition (Fink, Günther, & Hill, 2011). There are also co-benefits to hand pump installation. Construction of a hand-pumped well has also been shown to reduce injury and the muscle and joint discomfort associated with manually lifting water from a well (Vanderwal et al., 2011). Finally, attendees were significantly more likely to be able to demonstrate proper hand washing technique and to describe at least five ways to prevent diarrheal disease. Knowledge of good hygiene behavior such as hand washing is one of the unmet health needs identified by women in Haiti even before the 2010 earthquake (Peragallo Urrutia et al., 2012). Hygiene behaviors are also key to the sustainability of a WASH program. A recent review of current sanitation literature from Ethiopia and Haiti suggests the installation of improved water or improved sanitation facilities must be combined with a sustained change in hygiene behavior to effectively reduce diarrheal disease (Wake & Tolessa, 2012).

Conclusion

Overall, it is difficult to describe the impact of Samaritan's Purse Canada WASH program on access to potable water, access to improved sanitation, and knowledge of good hygiene behavior within participating communities without improvements in data collection methodology. Households report substantial use of bathing and laundry facilities as well as improved sanitation. Use of hand-pumped drilled wells is associated with lower rates of diarrheal disease in children under five years old. Future recommendations for Samaritan's Purse WASH programs in Haiti and in other countries include providing identification for individual households within the survey and introducing quality assurance measures to promote interviewer consistency. This evaluation sheds light on the problems associated with survey design and data collection in multi-intervention WASH programs within developing countries. There is still an enormous need for the evaluation of WASH programs following manmade or natural disasters.

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APPENDIX

HOUSEHOLD AND LATRINE SURVEYS IN ENGLISH

Household Survey Questions and Interviewer Observations

Identification:

Date (auto-recorded)

Name of Interviewer:

Name of Community:

Number of Household:

Follow-up Month:

Gender of Respondent:

Age of Respondent:

Demographics:

What is the total number of men 0-4 years old living in the household over the past 3 months?

What is the total number of men 5-18 years old living in the household over the past 3 months?

What is the total number of men 19-54 years old living in the household over the past 3 months?

What is the total number of men 55+ years old living in the household over the past 3 months?

What is the total number of women 0-4 years old living in the household over the past 3 months?

What is the total number of women 5-18 years old living in the household over the past 3 months?

What is the total number of women 19-54 years old living in the household over the past 3 months?

What is the total number of women 55+ years old living in the household over the past 3 months?

Ask the following questions to the head of household:

What is the primary source of drinking water for your household? (Choose one response)

A Surface water-river/stream/pond/lake/canal

B Protected dug/shallow well

C Unprotected dug/shallow well

D Borehole/hand pump

E Rain water

F Protected spring

G Unprotected spring

H Piped to dwelling

I Untreated public tap

J Treated public tap

K Vendor

How many minutes does it take to walk to your drinking water source, retrieve water, and return to your home?

Who usually collects the water? (Choose only one response)

A Men

B Women

C Children (aged 4-13)

D Both women and children

Do you treat your water before you drink it?

1 Yes

2 No

How do you treat your water (Record all that apply)

A Settling water so that sediment sinks to the bottom

B Straining (water passes through a preliminary filter or piece of cloth)

C Filtering

D Boiling

E Chlorination (addition of bleach, chlorine, or aquatabs)

Do you use a laundry slab?

1 Yes

2 No

If yes, do you use the laundry slab constructed by your community and Samaritan's Purse?

1 Yes

2 No

Why not?

A Too far from the house

B Too many people using it

C Not enough space to dry clothes

D Not private enough

E Other

Do you get your water for laundry from the same source as your drinking water?

1 Yes

2 No

Where do you get your water for laundry? (Choose only one response)

A Surface water-river/stream/pond/lake/canal

B Protected dug/shallow well

C Unprotected dug/shallow well

D Borehole/hand pump

E Rain water

F Protected spring

G Unprotected spring

H Piped to dwelling

I Untreated public tap

J Treated public tap

K Vendor

Do you use a bath house?

1 Yes

2 No

If yes, do you use the bath house constructed by your community and Samaritan's Purse?

1 Yes

2 No

If no, why?

A Too far from the house

B Too many people using it

C Not private enough

D Have a private bath house at their dwelling

Other

Do you get your water for bathing from the same source as your drinking water?

1 Yes

2 No

Where do you get your water for bathing? (Choose only one response)

A Surface water-river/stream/pond/lake/canal

B Protected dug/shallow well

C Unprotected dug/shallow well

D Borehole/hand pump

E Rain water

F Protected spring

G Unprotected spring

H Piped to dwelling

I Untreated public tap

J Treated public tap

K Vendor

Do you treat the water you use for bathing?

1 Yes

2 No

How do you treat your water for bathing? (Record all that apply)

A Settling water so that sediment sinks to the bottom

B Straining (water passes through a preliminary filter or piece of cloth)

C Filtering

D Boiling

E Chlorination (addition of bleach, chlorine, or aquatabs)

What type of sanitation facility (toilet or latrine) is used by the household? (Choose only one response)

A None / field / banana trees

B Pit latrine with no slab

C Pit latrine with slab

D Pour / Flush

E VIP (Ventilated Improved Pit) latrine

F Other

Where is the latrine located?

A At household

B At a neighbor's household

C Community

Interviewer: Ask if there is soap in the household and to see it. If no soap is produced in 1 minute, record no soap.

1 Yes, there is soap

2 No, there is no soap

3 Cannot observe

Interviewer: Ask to observe the respondent wash their hands. (Record all that apply.)

A Uses purified water or water from the well

B Rubs hands together at least three times

C Uses soap

D Washes both hands

E Dries with air or clean cloth

F Cannot observe

When do you wash your hands with soap? (Do not read answers. Encourage replies until nothing further is mentioned. Record all that apply)

A Before food preparation

B Before eating

C After defecation

D After helping child who has defecated

E Before feeding children

F Never

G Other

Did any child less than 5 years of age in your household have diarrhea in the past two weeks? (Diarrhea: 3 or more liquid stools in 24 hours)

1 Yes

2 No

0 No children under 5 in the household

If yes, how many?

Did any person 5 years of age or over in the household have diarrhea in the past two weeks? (Diarrhea: 3 or more liquid stools in 24 hours)

1 Yes

2 No

If yes, how many?

Do you know any ways that diarrhea can be prevented? (Do not read answers. Encourage responses until nothing further is mentioned. Record all that apply)

A Wash hands

B Use soap

C Use toilet facility to defecate

D Drink clean, treated water

E Prepare food hygienically

F Not known

G Other

Did you attend any of the health and hygiene meetings presented in your community by Samaritan's Purse staff?

1 Yes

2 No

If yes, how many?

1

2

3

4

Have you been impacted spiritually by this project?

1 Yes

2 No

If yes, how would you say you have been impacted?

A Increased knowledge of Christianity

B Increased desire to attend church

C Deeper relationship with God

D Other

Have you started attending your place of worship for the first time since Samaritan's Purse has been working in your community?

1 Yes

2 No

Have been more involved at your place of worship (attending more events, services, attending a small group, etc) since Samaritan's Purse has been working in your community?

1 Yes

2 No

Latrine Survey Questions and Interviewer Observations

Identification:

Date (auto-recorded)

Name of Interviewer:

Name of Community:

Number of Household:

Follow-up Month:

Ask the following questions to the head of household:

How many people live in this home?

How many people are using the latrine?

Why is the latrine not used?

- Broken
- Dark
- Flies
- Foul odor
- Pit is full

What do you dislike about the latrine?

- Dark
- Flies
- Foul odor
- Nothing

Does anyone in your household use the Tippy Tap?

- Yes
- No
- No Tippy Tap present

Why is the Tippy Tap not used?

Not interested

Broken

Do not use it in the rainy season

Do not have soap

Observe the following:

Take a picture of the outside of the latrine.

Are there any problems with the latrine structure?

No net or screen covering vent pipe

No open space for venting above the door

Open space for venting on rear or side walls

Damage to the structure

Take a picture of the inside of the latrine.

Are there any problems with the interior of the latrine?

Trash

Foul odor

Feces

Interior not kept dark

Toilet seat cover

Take a picture of the Tippy Tap.